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Concrete

1924

A Monthly Magazine of the Construction Field

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Concrete Road Building Progress In 1924

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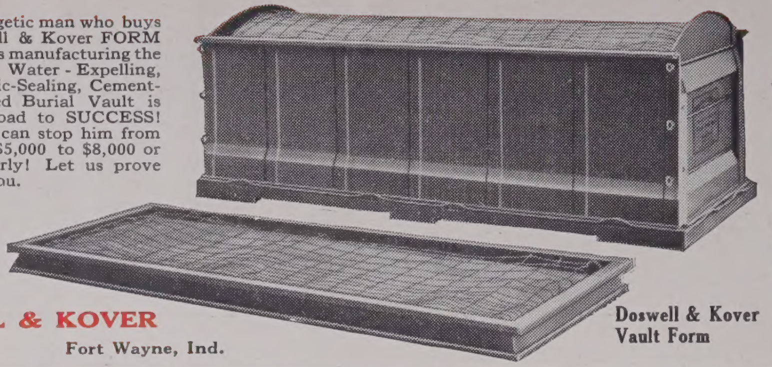

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Roads—Their Refinements

THE character and subject matter of the discussions of concrete road building problems to be found in the pages of this issue reveal a state of progress that must be highly gratifying to the bold pioneers who were first to apply this material to highway purposes.

Their wisdom or foolhardiness—depending upon the outcome—was once the major topic. Whether or not concrete should be used is not now debated. Yet concrete road building is far from static. While we are a long way from the end of our knowledge, such knowledge as we have is more generally accepted and if a modification of design is to be strongly recommended, it will generally be found applied in many places. The whole concrete road building fraternity is no longer topsy turvy with conflicting recommendations and practices.

The concrete road is now undergoing refinement—

Refinement of design with some definite idea of the requirements of traffic.

Refinement of mix and proportions with a very definite idea of the quality of concrete to be obtained.

Refinement of plant and organization to eliminate lost motion.

Refinement of surface riding qualities and escape from the destructiveness of impact which irregularities greatly increase.

Refinement of the highway itself in its aesthetic appeal such as tree planting and road-side parks.

Refinement in provisions for the safety and comfort of motorists and foot passengers.

Some of these developments are in their infancy but they are recognized and it is only a matter of time and the exercise of thought and patience when these refinements must assume everywhere a compelling economic importance:

Refinement of design and of mix proportions—itself now a matter of deliberate design—to get the most wear from the least material, the most traffic use per dollar, and to use materials heretofore deemed unsuitable.

Refinement of plant and organization to increase the per man output of road yardage.

Of riding qualities to save the vehicle, the passenger and the slab itself from destruction.

Refinement in the road setting because this is an investment in the country traversed and in the pleasure of the people traversing it—and both these have dollar value.

In safety, because we count life and health as tangible assets.

An escape from the more general problems brings a multitude of other detailed problems. With the same materials plus coordinated thought we are giving more transportation service per dollar spent.

* * *

How's Business?

OF PSYCHOLOGICAL effects on business a good deal has been said. If a sufficient number of men who hold the key situations in business and industrial life believe that business is going to slump, it slumps—and that without paying any tribute to their reasoning powers. It is sufficient for the purposes of a business slump that it was generally predicted. And for opposite reasons we may look cheerfully into the sphinx-like countenance of 1925. So many people have found so many reasons why business is to be good in 1925 that we may be quite happy about the prospects.

Whether the *reasons* they found are or are not sound and logical is of less consequence probably than the fact that, such as they are, they have been found. For business will usually be good in proportion to the number who believe it will be and they are considerable.

Belief works in untold ways. A middle-west contractor of large activities wrote us some months ago:

"The pessimist is a genius for developing causes for worry about the future. He needs little to build up a plausible argument in spite of there having been presidential elections every four years since 1776 or so. That is still a seemingly solid foundation for the pessimist's belief that possible change will work hardship. But that is passing. Future bridges are losing their terror; business men are thinking things through and are less subject to pessimistic expectations."

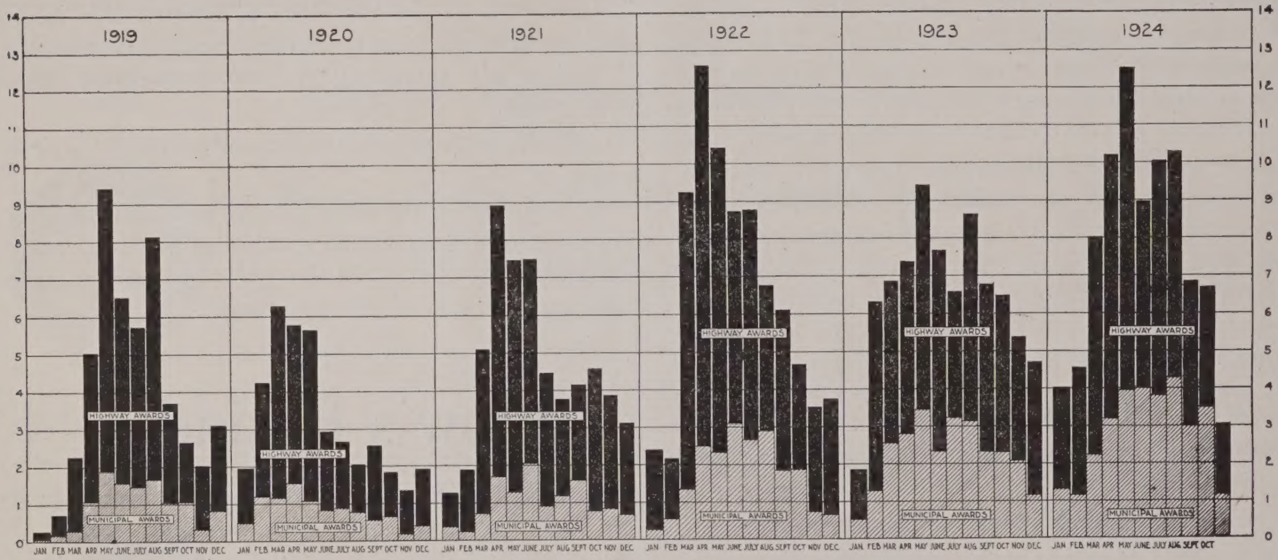
He points out shrewdly that when Babson or Brookmire states it is wise that building be deferred, enough building is deferred to change somewhat the fundamental conditions on which the advice was given, thus making it wise that considerable building be allowed to *go forward.* Unquestionably the economic forecast services have been beneficial in ironing out the peaks. This and many other factors seem to account for the initiation of much new construction.

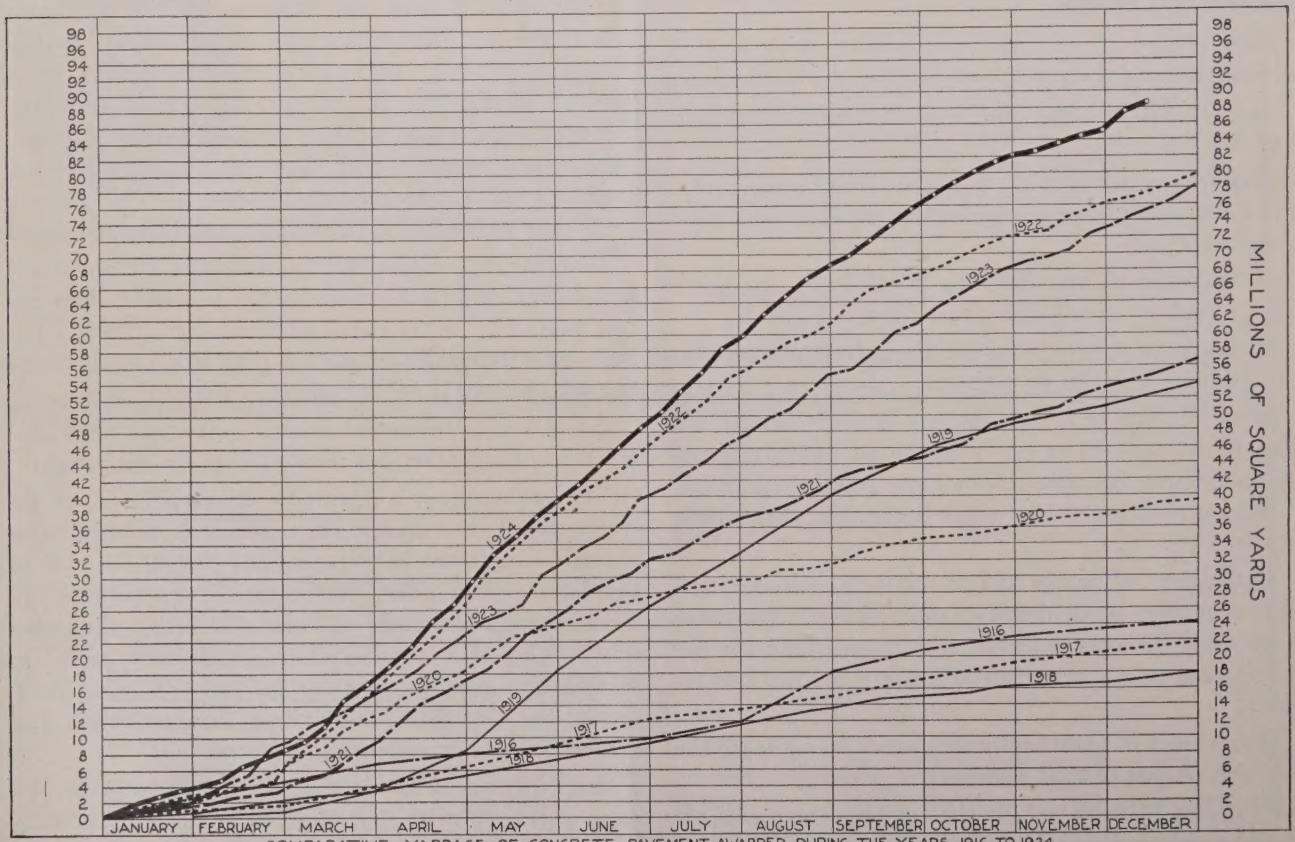
A period of slackness—as for instance in building apartment houses or homes in districts where "for rent" or "for sale" signs are plentiful—always brings constructive investigation of new channels of activity and there are plenty of opportunities in every city.

These suggestions came two months before the presidential election and now everybody, so far as can be discovered, believes in a good building volume in 1925.

Yardage of Concrete Roads in 1924

Courtesy The Portland Cement Association





COMPARATIVE YARDAGE OF CONCRETE PAVEMENT AWARDED DURING THE YEARS 1916 TO 1924

What Concrete Road Builders Are Thinking About

A Symposium

This is CONCRETE's annual review of concrete road building thought and practice — a symposium to which brief discussions are contributed by C. R. Ege, R. M. Morton, Edward N. Hines, H. J. Kuelling, George A. Reed, B. S. Pease, W. F. Reichardt, C. M. Conner, R. W. Crum, E. R. Hoffman, B. H. Piepmeier and Frank F. Rogers.

Outstanding Features of 1924 Work

By C. R. Ege

MANAGER HIGHWAYS BUREAU, PORTLAND CEMENT ASSN.

Outstanding features of concrete road construction in 1924 have been the universal adoption of the basic design brought out by the Bates experimental road tests in Illinois. Practically all states and counties building concrete roads in 1924 have selected a cross-section representing some modification of the present Illinois standard design. The basic principle of this design is that the section has its greatest thickness at the outer edges. The principle of securing uniform strength throughout the limits of the slab has been extended to pavements wider than the usual 18 ft. rural highway. This result is secured by dividing the wide pavements into longitudinal sections usually not over 10 ft. in width, adjacent sections being mutually supported by means of cross dowels or some type of interlocking joint.

In 1923, highway contractors began to devote special attention to producing concrete pavements of great excellence as to riding surface. This attention has been continued and intensified during 1924 by means of many special devices. These differ in design and methods of use but all serve the common purpose of improving the riding qualities of the finished pavement. The outstanding development in regard to material handling has occurred in Iowa where all stone and sand put into concrete road mixtures in 1924 were proportioned by weight. This has attracted the study of officials in other states and there is reason to believe that 1925 will see an increased application of this method of measuring proportions.

Road designing has been influenced by the ever increasing volume of traffic. This has led highway engineers to devote more attention to the design of the roadway at critical points where the flow of traffic is subject to interference. Pavements have been widened at highway intersections; more and more attention has been given to eliminating railway grade-crossings and connections with city thoroughfares have been planned to accommodate the peak traffic loads.

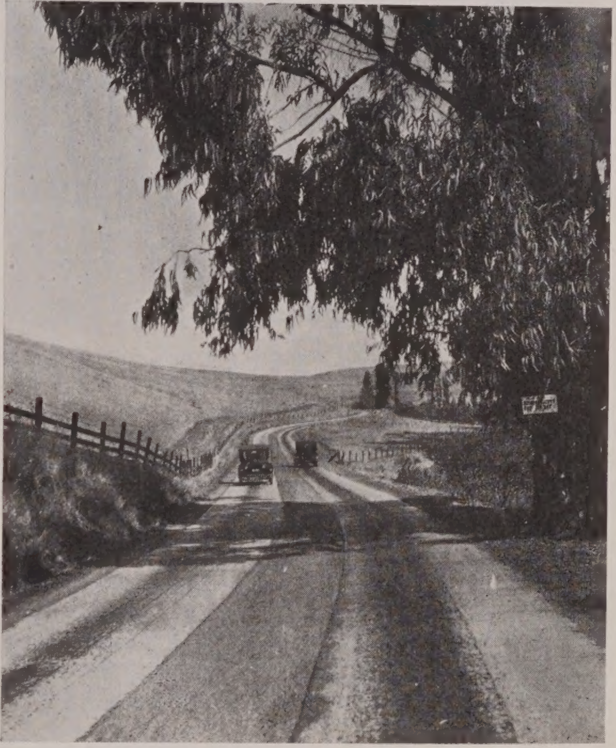


Fig. 1—Franklin Canon Road, Contra Costa county, California

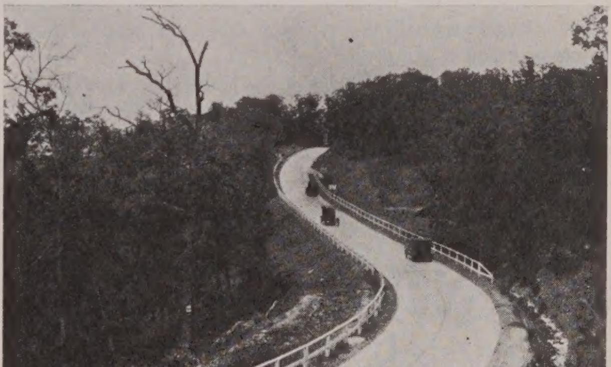


Fig. 2—Between Ottawa and La Salle, La Salle county, Illinois

The number of highways of unusual width now being built has developed some new finishing methods and machines for the purpose.

In the field of resurfacing of old highway pavements much has been accomplished. The State of California has resurfaced many miles of concrete originally built to widths of 15 ft. and thicknesses of only 4 in. Resurfacing and widening has been accomplished in one operation. So much along this line has been done and has been under traffic a sufficient length of time that engineers are utilizing with confidence this method of rehabilitating old surfaces.

So far as the user of the highways is concerned, probably the most important development is the improvement in contractors' organizations, which has resulted in turning out a greater volume of completed pavement than ever before. Despite unfavorable weather conditions in nearly all parts of the country during the first half of the summer, more than 57,000,000 square yards of new concrete highways were completed and placed under traffic between January 1 and November 1, 1924. This exceeds any previous year's record. It speaks volumes for the efficiency of the contractors' organizations.

* * *

Pay for Road on Strength Basis

By R. M. Morton

State Highway Engineer, Sacramento, Calif.

During 1924, we definitely adopted the thick edge pavement and the expansion joint 1½-in. in width at intervals of 100 ft. We have adopted the practice allowing variation in subgrade up to ½ in. extra depth and pay contractors for the additional cement used. This is a recognition of the fact that on construction work where we require a heavily rolled subgrade, it is not humanly possible at this time to secure a subgrade perfect within the limits at reasonable expense.

By closer attention to proposed grading of aggregate and amount of water, we have been able to raise our concrete strength on concrete running 6 bags to the yard from about 2,000 to an average of about 4,000 lbs. compressive strength at 28 days. In a number of cases, where materials are particularly good, we have been able to hold the strength at about 5,000 lbs. for 28 days.

For next year's work, it is planned to experiment with the inundation method of controlling water and we also have under discussion the possibility of including a clause under which contractors will be paid on strength of concrete as well as on cubic yardage.

A number of different types of road building organizations have been tried out during the year and at the present time it seems the central proportioning plant idea using industrial railway is the most generally satisfactory. Central mixing plants have been used to a certain extent but their results have not been particularly encouraging.

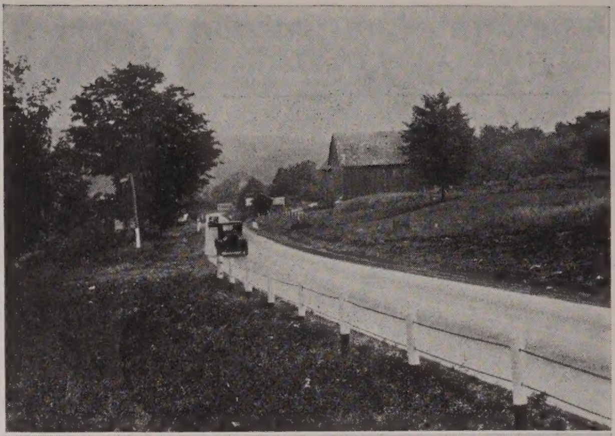
* * *

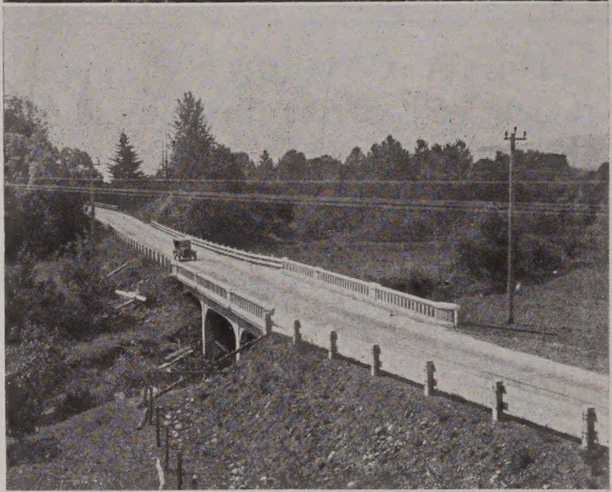
What Wayne County, Mich., Is Doing

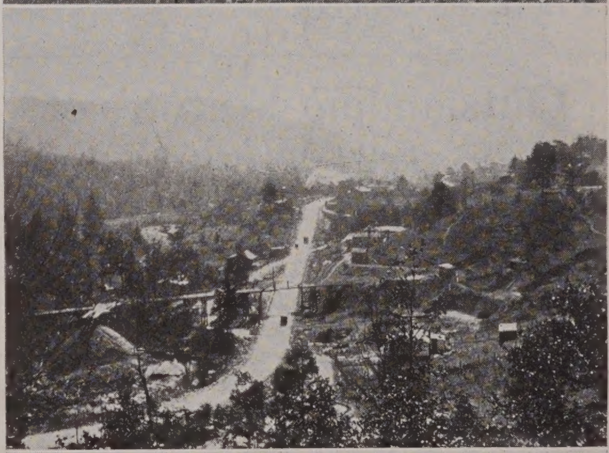
By Edward N. Hines

Chairman Board of County Road Commissioners, Wayne County, Mich.

The Wayne County Road Commission has come to a realization that rights of way are fundamental. For several years past we have been groping around in an effort to correct and relieve traffic congestion. One hundred foot rights of way have been acquired on some of our radial highways out of Detroit, such as Michigan, Woodward and Grand River Roads. Many double concrete highways have been constructed, ranging from 40 ft. in a single roadway to 70 ft.







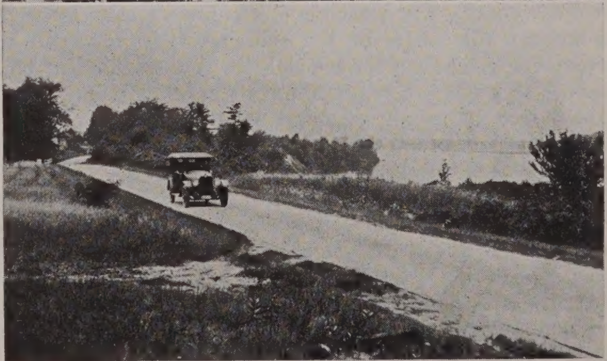
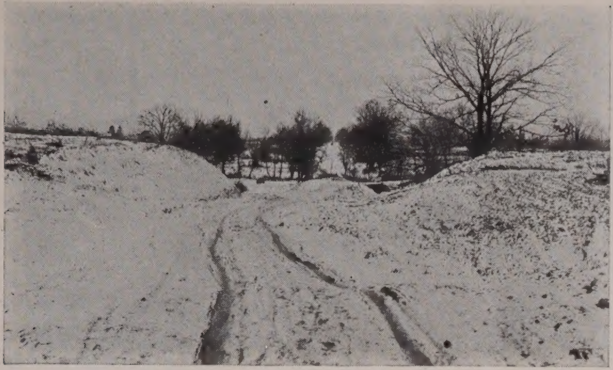


Fig. 3 (Top)—Meadowville-Conneaut Lake Road, Crawford county, Pa.

Fig. 4—Goble Creek Bridge, Pacific Highway between Kelso and Kalama, Cowlitz county, Washington

Fig. 5—Norton-Esserville Road, built 1921, near Norton, Wise county, Virginia

Fig. 6 (Bottom)—Waddington-Massena Road, New York



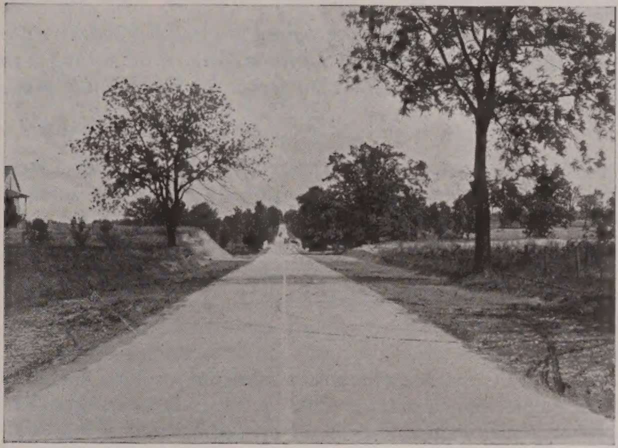


Fig. 7—Telegraph Road south of Bell Branch, Wayne county, Michigan, before improvement

Fig. 8—Telegraph Road at the same point after improvement with 20-ft. concrete road and a new reinforced concrete bridge over a branch of the Rouge River

between curbs with provision for interurban tracks in the center.

But no sooner has an improvement of this character taken place than the road immediately becomes congested with traffic. We have come to realize that half measures are useless and are now striking out boldly with a new right of way plan in cooperation with the Rapid Transit Commission of Detroit and others. All the history of the past shows that our failures have been due to underestimating the future rather than in overshooting the mark.

All of the territory in Wayne County that lies within a 15 mile radius from the City Hall is now being mapped with respect to the widths of rights of way of all mile, half-mile radial and other important roads. Every half-mile road is being planned for a minimum 86 ft. width, every mile a full 120 ft. except that every third mile road is having 84 ft. added for future rapid transit needs, making a total of 204 ft. for these super-highways. Radial main arteries, which are of greater importance than meridian roads, since they have no main parallel highways, are being planned for a right of way of 204 ft.

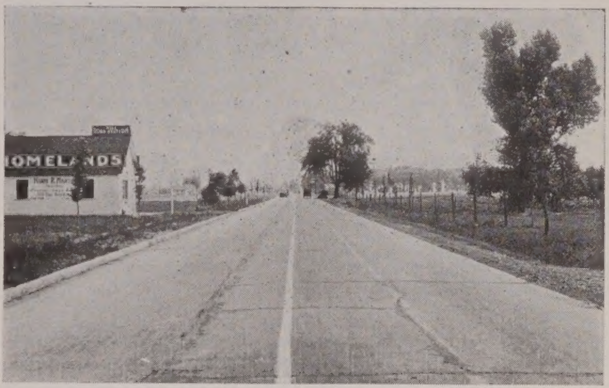
The foregoing plan for the super-highways of the Twentieth Century seems to me to be our biggest accomplishment. Some necessary legislation to carry this out in full is being prepared and will be submitted to the legislature and we have every reason to believe that our recommendations will become enacted in a law.

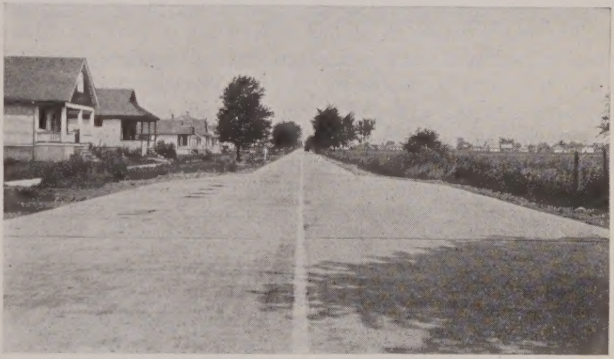
We consider the thing that is vital and fundamental is to obtain the rights of way now as the land naturally will never be cheaper than it is today. The construction of the highways themselves will be a gradual process.

Another outstanding accomplishment is the establishment as a policy an ultimate, minimum width of 40 ft. of concrete on all main highways in Wayne county and all roads are now being graded to a width of 45 ft. so that when it becomes necessary to widen we will have a firm subgrade on which to work. In the past season two crews were kept busy continuously widening concrete roads of a lesser width than 18 ft. Where a road was not widened out to the ultimate, minimum width of 40 ft. the additional width was placed on one side of the right of way.

USE OF HIGH ALUMINA CEMENT

Another outstanding feature in our construction program this year has been the use of lumnite cement for patching purposes. Our policy is to keep traffic moving and where it has been necessary to patch, by the use of lumnite cement the road can be thrown open for traffic within 24 hours.





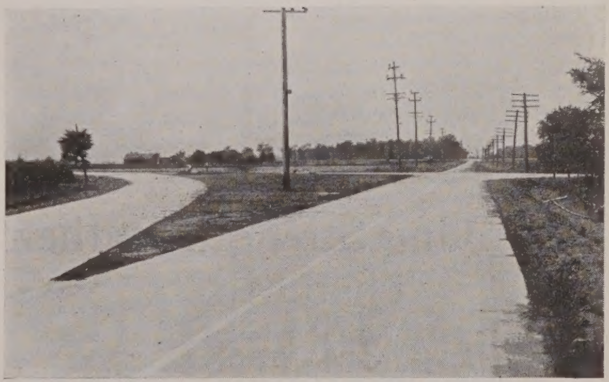


Fig. 9—Seven Mile Road between Southfield and Division Roads, Wayne County, Michigan, widened from 18 to 30 ft., preliminary to widening to the ultimate minimum width of 40 ft.

Fig. 10—Schoenherr Road, also in Wayne county, just north of Seven Mile Road, which connects with a new concrete road in Macomb county, opening up a new route to Mount Clemens. This road is 20 ft. wide in Wayne county and near the intersection with the Seven Mile Road it is 40 ft. wide

Fig. 11—Intersection of Ecorse Road with Allen Road two miles west of Lincoln Park, Wayne county, Michigan. New right of way was acquired at this location, thereby eliminating two right angle turns and shortening the road 800 ft.

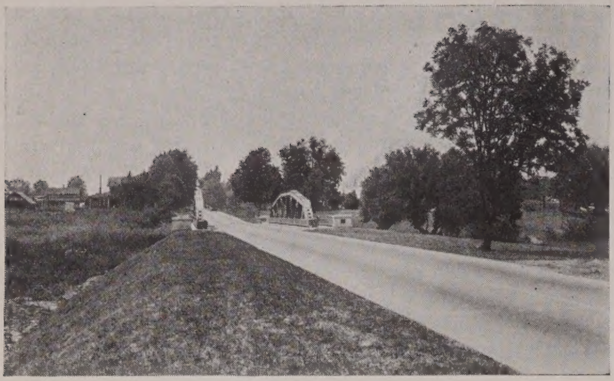


Fig. 12—View of bridge on Five Mile Road near Brightmoor, Wayne county, Michigan. The banks are neatly sodded

We have also used lumnite cement for the construction of a bridge floor where the bridge construction had lagged a little behind the road construction, and instead of tying up the roadway for 28 days, the usual curing period, the bridge was tied up only 48 hours.

Another development has been the use of gunite on all exposed steel work on grade separation projects. Gunite has made a sightly and satisfactory job wherever we have used it on grade separations and minimizes maintenance.

To avoid costly reconstruction as the city expands its limits, roads in districts where it is anticipated city expansion will take place, are now being built to city grade with curb, gutter, sewer and catch basins. There was one recent lesson in the wastefulness of doing otherwise: a part of Mack Avenue concreted eight years ago and still in first class condition was torn to pieces by the city in order to lower the grade.

In anticipation of wider roads in the future on main highways, Wayne county has built its first bridge having a roadway 40 ft. in the clear, and this is 20 miles out of the city on the Toledo road. Several more 40 ft. bridges will be built in 1925.

All road intersections are being widened 40 ft. for a distance of 200 ft. on all four sides of crossings.

The county has adopted a woven wire life net type of guard for dangerous curves and embankments and this is being set up with wooden posts so as not to destroy the motor cars by hitting concrete posts, but with concrete anchorages for strength.

Among other outstanding developments of a highway satisfactory for public service, as distinguished from mere roads, the county has built recently three comfort stations of permanent construction and will build two more next season.

* * *

Specifying Strength Rather Than Mix

By H. J. Kuelling

Construction Engineer, Wisconsin Highway Commission, Madison

There is almost a common practice now of building concrete roads with the edge thicker than the side. The Wisconsin section, used quite largely in 1924, and which will be used entirely in 1925, is 9 in. thick at the edge, tapering to 6½ in. in the first 4 ft. and being of 6½ in. uniform thickness from there to the center. Owing to the fact that it is believed that most damage is done to concrete roads by a very small percentage of the traffic consisting of overloaded trucks, and since these are likely to be on any road, we have only one edge thickness in our design.

Longitudinal joints have become a common practice but the instal ion of these has not reached perfection. We have several ki s of installing devices in use in Wisconsin which are giving us quite general satisfaction in getting these steel plates fairly true to line and within ¼ in. of the surface. These all consist of some device that is held in place by the forms and straddles the center steel with a double line of so-called rake teeth.

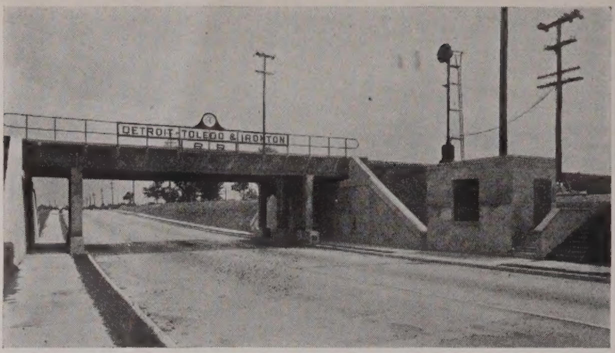


Fig. 13—Grade separation on Oakwood Boulevard, showing typical pumphouse, Wayne county, Michigan. All steel work is covered with gunite and all banks are neatly sodded. The Wayne County Road Commissioners are urging all railroads in Wayne county to signboard their grade crossings and grade separations

All joints, whether longitudinal or transverse, are being doweled with rods 4 ft. long with one end of the dowel free in the transverse joints.

One step in advance which is being taken in more and more states is better stock piling, namely piling in layers rather than in cones, thus tending to prevent the segregation of material. This certainly is a step toward more uniform proportioning of aggregates.

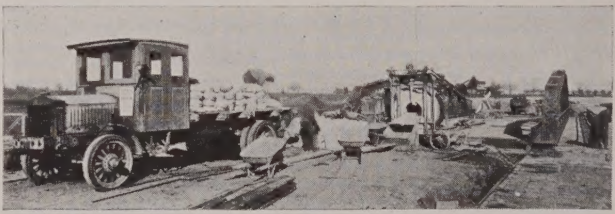


Fig. 14—A Wayne county bridge, floored with Lumnite cement concrete and driven over by heavy trucks 48 hours later

I believe there will be a greater tendency to return to transverse joints for contraction purposes. Transverse joints for expansion are not so necessary except in cooler weather but for contraction purposes they are apparently necessary at all times of the year to prevent uneven and unsightly cracks. We believe these are worth their cost for this purpose. These can well be built of a very thin compound of some kind or even of steel merely to serve to make the cracks straight. Their spacing will depend largely upon the kind of subgrade the road rests on.

The measuring of aggregates is becoming more accurate but always contains the error of moisture. The swelling due to moisture is luckily on the safe side. In other words a 1:2 mortar of damp sand will give a stronger mortar than a 1:2 mortar of the same sand in dry condition. In other words we are building a different quality of concrete as the moisture content varies. It would therefore seem that the weighing of aggregates is a step in the right direction, especially with the fine aggregates.

The biggest advance that appears is the inclination to specify strength rather than mix. In other words, all materials should not be treated alike.

The use of Alumina and Ferric cement will become more and more common for special work at the ends of jobs, on bridge floors, for repairs, etc. With the greater strength that these cements give there will be a growing demand for better portland cement. This will be particularly so when we commonly specify the strength desired rather than a hit-and-miss proportion. This will naturally mean that the amount of cement incorporated in a road will vary considerably with the kinds of materials available for the job.

As an outgrowth of road work we will soon see central plants in the cities furnishing any quality of concrete desired by an architect or an engineer. This will be true because such a plant can have many sizes of aggregates and proportion them all, giving varying qualities of resulting concrete. This will enable the architect or engineer to design his concrete in a better way as he will have more consistent materials to deal with. It will also result in the mixing on the building site being gradually done away with and the concrete trucked to the site.

* * *

The Vermont Section

By George A. Reed

Assistant Chief Engineer, State Highway Board, Montpelier, Vermont

A couple of years ago the writer designed the system of reinforcing and road slab here described, known as "The Vermont Section." This has since been used successfully in Vermont with good results where reinforced concrete rather than plain concrete is required.

Concrete roads in Vermont are laid 18 ft wide in two sections, one-half at a time thus making a longitudinal joint through the center, except that curves having a radius less than 1.146 ft. are widened and banked.

The reinforced concrete roads have a uniform thickness of 7 in. unless extraordinary conditions make a change advisable. A uniform slope of 2 in. in the 9 ft. width is used.

It is found that a much smoother surface can be obtained by laying the concrete in two 9-ft. widths and smoothing with a straight line screed than can be obtained by laying the whole width at once. Transitions from the regular section to the banked section can also be accomplished much more satisfactorily with the half length straight screed.

The reinforcing mat is shown in the figure. Transverse reinforcing consists of double bar road units assembled at the factory and held by riveted strap iron chairs. An important

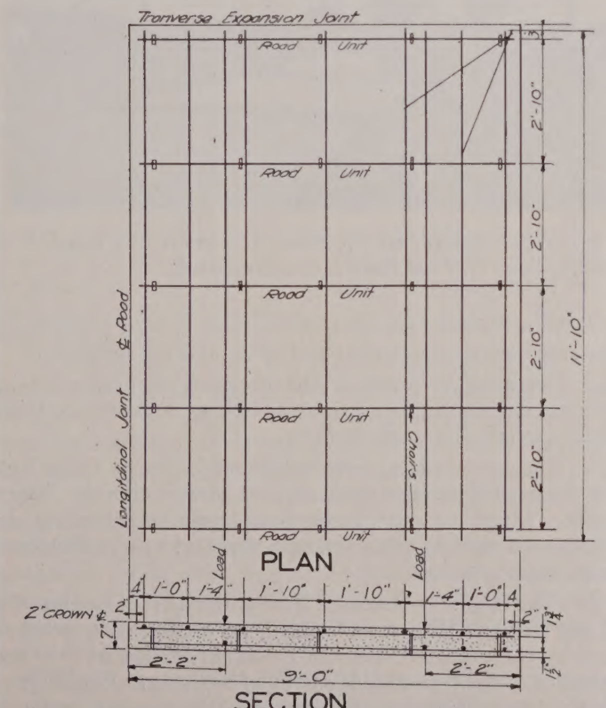
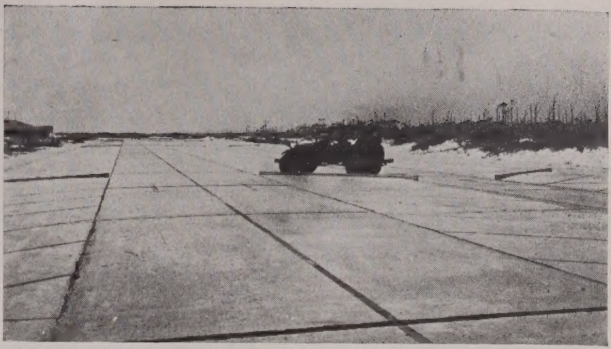


Fig. 17—The Vermont Section



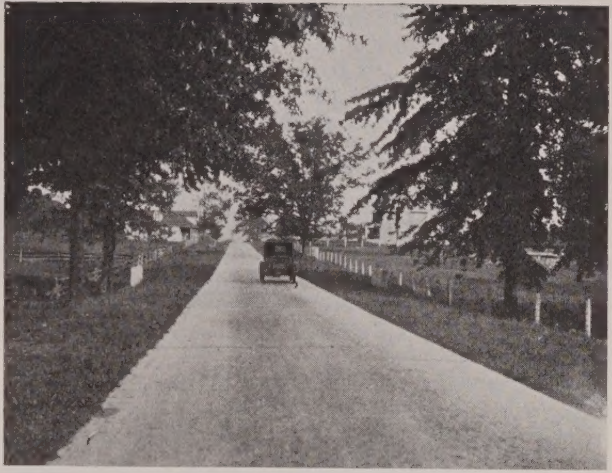
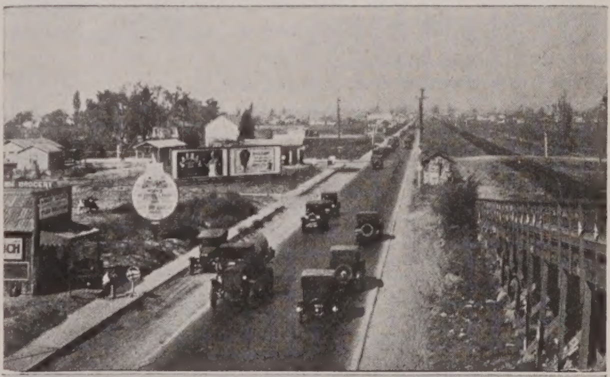


Fig. 15—Parking space has concrete bumper to confine travel to driveways
Gulf Beach Highway, built 1923, Escambia county, Florida
Fig. 16—Naamans Creek Road, built 1920, New Castle county, Delaware



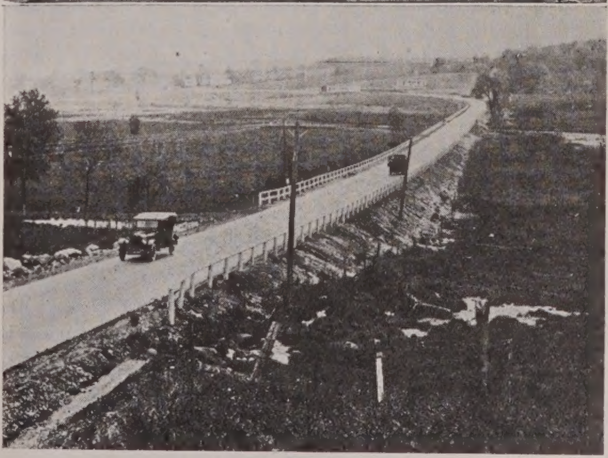


Fig. 18—Harbor Truck Boulevard, Los Angeles
Fig. 19—State Trunk Highway No. 41, Waukesha county, Wisconsin

function of these road units is to support the longitudinal bars and, with the help of clips, to hold the bars securely in place.

The longitudinal bars are spaced as shown, the top ones being nearer together at the edges than at the center to better care for transverse stresses beginning at the edges. Three bottom bars are placed near the outside edge to care for the stresses shown by the Bates' tests to exist at this point. By caring for these stresses by reinforcing steel instead of a thickened edge of concrete, some concrete may be saved as well as a great amount of fussy work by the contractor in preparing the subgrade; also avaoiding the use of special forms on the outside edge.

One of these three bottom bars and another one 2 ft. 2 in. from the center joint are underneath the wheel loads when the vehicle is in its normal position in the center of the slab. Two 3-ft. bars are placed at the outside corner of each slab to prevent corner breaks. Four mats are usually placed between transverse expansion joints but the number may be varied. One of the road units is omitted from the end of each mat except the end mat of each slab, the longitudinal bars lapping on the mat previously placed 6 in.

All bars are ⅜-in. round, deformed; ¾ in. round deformed dowels 2 ft. long are placed across the longitudinal joint spaced about 3 ft. 4 in. on centers; ¾-in. round plain dowels 2 ft. long are placed across the transverse joints, one-half being wrapped with paper to assure slipping when expansion or contraction occurs.

The weight of steel in the mats is 75.1 lbs. per 100 sq. ft., the dowels weighing 8 lbs. for the same area, making a total of 83.1 lbs. per 100 sq. ft. of pavement or about 38.5 lbs. per cu. yd.

The cost of the steel has been about 33c per sq. yd. and the cost of assembling has cost about 2c per sq. yd.

Contractors who have used this mat have been much pleased with the plan. Mats are assembled and placed along side the road in advance and very little interruption is experienced in placing the mats in the road, the mixer being detained a much shorter time than when other systems are used. No trouble in operation is experienced or voids in the concrete found such as may be possible when sleds are used to support the mats and drawn ahead with the mixer.

The engineer, by the method above described, knows that he has a dense concrete, that he has the right amount of steel, and that it is correctly placed.

* * *

Reinforcement

By B. S. Pease

American Steel and Wire Co., Chicago

Some of the outstanding features of pavement and roadway building during 1924 may be summed up briefly as follows:

1. A large majority of the concrete city pavements were reinforced over the entire area of the slab. Wire fabric reinforcement was the standard.

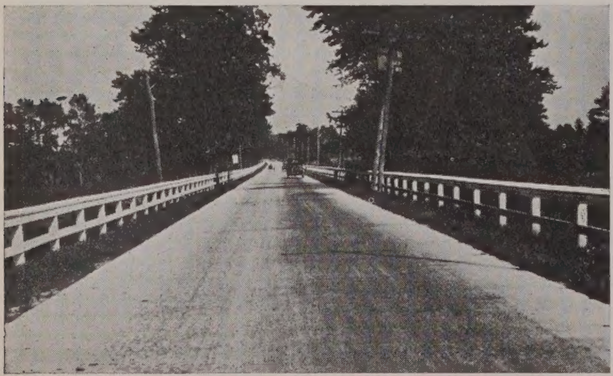
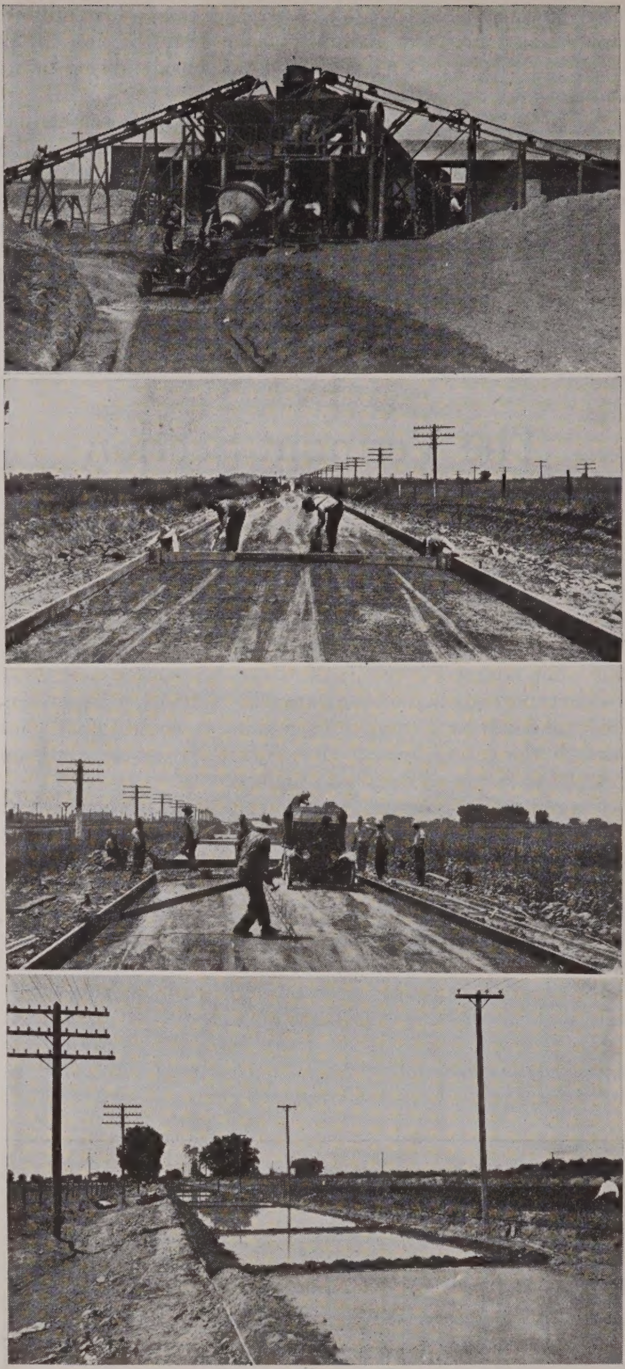


Fig. 20—Near Framingdale, built 1921, Monmouth county, N.J.



Figs. 21-24—Central mixing plant, Denver-Greeley Road, Weld county, Colo. J. Fred Roberts Construction Co.

2. An increased yardage was constructed with a reinforced concrete base under asphalt and brick wearing surfaces.

3. Increasing evidence of the necessity of properly reinforcing concrete highway slabs including the concrete bases under asphalt and brick surfaces.

4. Thickened edges, dowelled center joints, and edge bars are not sufficient assurance against destruction by heavy traffic. Interior corners at the joints, and all corners of the cracks need the additional strength supplied by a suitable wire fabric reinforcement.

5. The Highway Research Board, Division of Engineering of the National Research Council, an organization perpetuated by the executive order of President Wilson in 1919 and attached to the National Academy of Sciences at Washington, D. C., has undertaken the study of the economic value of reinforcement in concrete slabs. This study will be based on the millions of square yards of reinforced concrete pavement

and roadways which have been constructed since 1910. The economic value as determined by the research should have a decided influence on the future designs of highway slabs.

* * *

Money for Steel Well Spent

By *W. F. Reichardt*

Consulting Municipal Engineer, Watertown, Wis.

If there is any one detail of construction of concrete pavements that stands out alone in my mind, it is that of reinforcement, and while I have always reinforced my pavements, I am more firmly convinced that money invested in steel is well spent.

I have had occasion to view some pavements in this state that have not been reinforced, and I find that they have gone to pieces, whereas in the same vicinity other pavements reinforced are holding well under the heavy traffic.

A center joint, either blind or with an expansion material, is absolutely necessary, and where the pavement is of any width in excess of 30 ft. I think the use of an expansion joint is economy.

Too much attention is given to price or cost of the pavement instead of life of the pavement, and each year I find a tendency among officials to build as cheaply as possible. The small additional expense connected with paving in the use of suitable weight reinforcing is of little consequence in comparison with the ultimate value of the pavement.

I therefore have learned to design my pavements to meet traffic conditions regardless of cost, for if a municipality cannot afford the best design, they should then postpone their work until their finances can justify it.

* * *

Better Riding Surfaces

By *C. M. Conner*

State Construction Engineer, North Carolina State Highway Commission
Raleigh

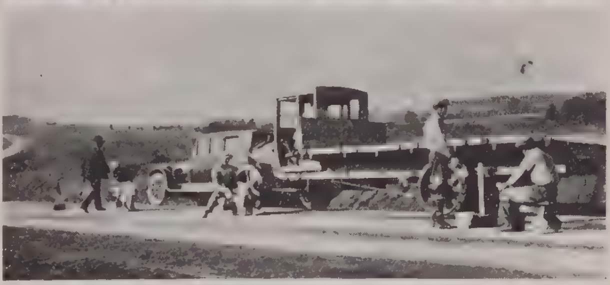
We have succeeded in securing smoother riding surfaces than ever before, by strict specifications and close inspection.

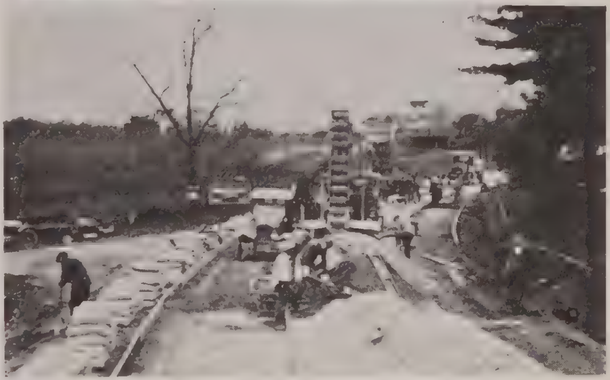
We specify in detail how the pavement surface shall be finished and cured and require new steel forms on all projects of three miles or more in length. We also require the contractor to use finishing tools as shown on our sheet of standards, and that then finishing machines are used they shall give a specified smoothness of surface or be removed.

We do not expect to change our designs materially as we are now using the thickened edge section on both plain and reinforced concrete pavement. Last year, we cut the curing period from 21 to 14 days with no difference in strength of cores or damage to pavement. This also allowed the road to be opened to traffic at an earlier date and cut down the curing costs to contractors which was reflected to some extent in their bid prices.

We expect to cut out the 14-day maintenance period on concrete and black top pavements and the adjacent earth shoulders. We may introduce a longitudinal hand float for finishing concrete pavements which will act as a straight edge and assist in removing slight irregularities in surface. We expect to continue to encourage our stone and gravel producers to furnish plenty of material between the ¾ and 1½ sizes. Our present requirements are 2¼ maximum uniformly graded to the ¼ size. We have found that the compressive strength of sand tested in 3 x 6 concrete cylinders should be a governing factor in the acceptance for fine aggregate as well as the standard tensile tests in briquettes.

We have developed a fabric reinforcement which we feel is a good substitute for the marginal bars which were formerly used. It is also much easier to install. We have built a concrete road on timber piles through swamp land where the swamp surface would not support a light fill of earth without disastrous settlement. The design of this pavement was based on the principle of the flat slab or mushroom system used in building construction.





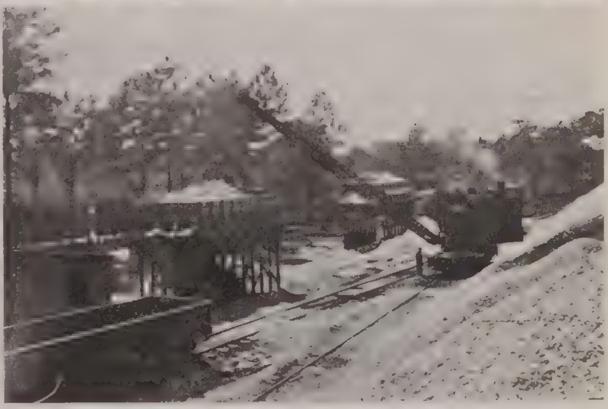
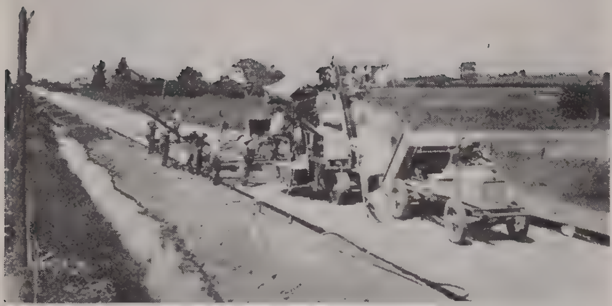


Fig. 25 (Top)—Section of Michigan's Super-Highway between Detroit and Pontiac—under construction. Woodward avenue, Oakland county, Michigan

Fig. 26—Painting and Traffic Marker—State Highway No. 20, Gaston county, N. C.

Fig. 27—Originally built 10 ft. Widened in 1923 to take care of two lanes of traffic. Richland county, Ohio

Fig. 28 (Bottom)—Material Bins and Piles, Lytle Construction Co., Sioux City, Iowa
Atlantic Beach Boulevard, Duval county, Florida



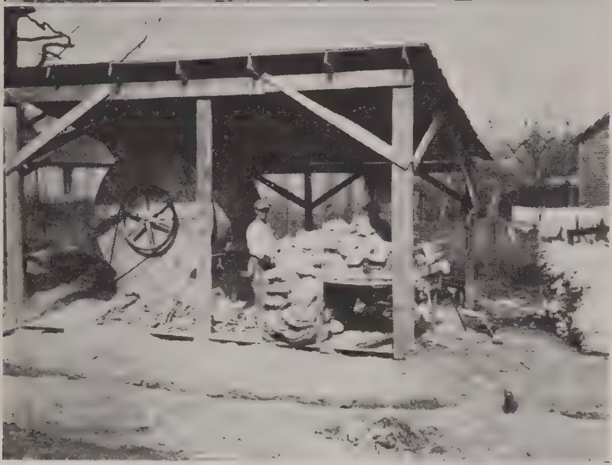


Fig. 29—Concrete mixer in operation. Route No. 20, Shelby county, Illinois

Fig. 30—Bag cleaner, E. Dixie Highway, Gray, Knox county, Kentucky

The total cost of piles, caps, reinforcement and pavement was less than for a timber trestle.

An Unusual Problem in Concrete Road Materials

An unusual and interesting problem in concrete road materials and construction was presented to the North Carolina Highway Engineers during the past working season.

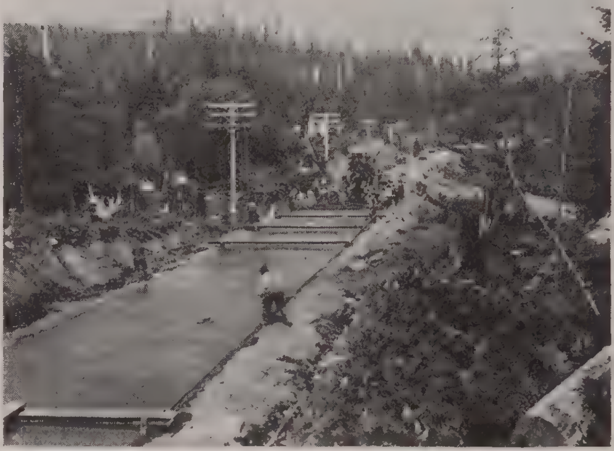
On a certain project all of the materials including cement, sand and stone had passed the specified requirements for physical tests. Concrete pavement had been in course of construction for sometime when an inspector discovered a very unusual condition in the appearance of the water in the ponds used for curing as well as of the pavement surface itself under the ponds.

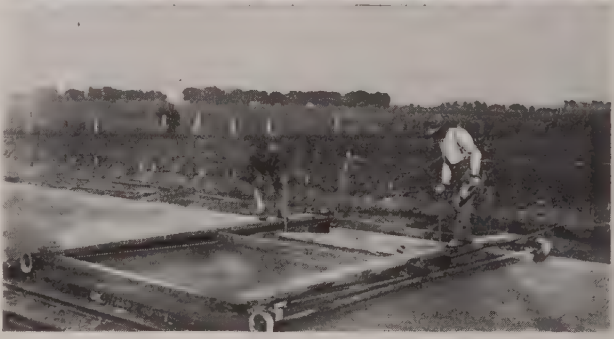
The ponding water was covered with a scum which floated on the surface while below the surface a greyish yellow material was held in suspension. The pavement surface itself showed a scale and was so soft it could easily be scratched with a sharp pointed instrument after having set for more than 16 days in warm weather. The work was at once shut down, all records of tests of materials were diligently scanned, construction engineers began a search for the cause and both the physical and chemical laboratories started an intensive investigation.

The scum and precipitate were first analyzed and found to contain over 90% calcium carbonate. The cement was found by check tests to pass both the physical and chemical requirements, although the physical tests showed it to be near the lower limits, on tensile strength. The sand passed the physical requirements but the chemical analysis showed about 300 parts per million of CO_2, the water used for ponding and mixing showed about 30 parts per million of the same acid.

The source of supply of sand, water and cement were changed and work resumed, but while the unsatisfactory conditions were nearly eliminated, yet a slight scum still appeared on the surface of the ponds. The earth used for forming the dykes in ponding was then chemically analyzed and was found to contain nearly 60 parts to the million of water soluble acid carbonate. Investigations and observations were continued and it was found in all cases after the curing period had elapsed and the pavement surface exposed to the sun and air, that its surface became as hard and firm when tested with a hammer as concrete laid under normal conditions.

However, to be doubly satisfied that no mistake should be made, the Highway Core Drill outfit took 6-in cores at frequent intervals on all of the completed pavement. The cores were at once suitably capped and then broken in the standard testing machine at the State Highway Physical Laboratory. Their ages ranged from 42 to 100 days and the breaking strength averaged well over 3000 lbs. per sq. in, after correction for height of cores, which, of course, is satisfactory for a 1:2:4 mix, which were the proportions used.





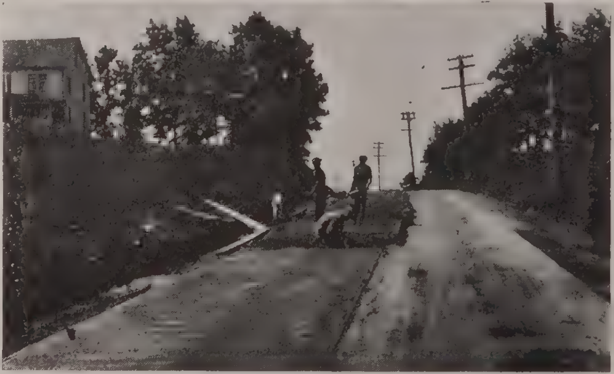


Fig. 31—State job of 6 miles. F. T. McClellan, Olympic Highway, Thurston county, Washington

Fig. 32—Straight edge from finishing bridge, Logan county, Ill.

Fig. 33—One half of road at a time constructed to allow for traffic. Hartford-Middletown Road, Rocky Hill Township, Hartford county, Connecticut

Refinement in Measuring Materials

By R. W. Crum

Engineer, Materials and Tests, Iowa State Highway Commission, Ames

We have made a decided improvement in the practice in building concrete pavements by requiring that the aggregates be weighed instead of measured by loose volume. This procedure became standard practice in Iowa this year and has been used with great satisfaction by sixteen different outfits. This refinement in measuring the materials has indicated to us very strongly the need of further refinement in the control of the quantity of mixing water. We are not certain as yet just how this may best be accomplished but feel that some means of holding a constant water-cement ratio is the most necessary refinement needed in making concrete.

There has been considerable progress in theories of designs of concrete pavements and we expect to take advantage of the most up to date methods in designing our pavements for next season. We have, however, not done anything original along this line.

* * *

No Design Change Since Thickened Edge

By E. R. Hoffman

Construction Engineer, Washington Division-of-Highways, Olympia

No material change has been made in the design of our concrete pavement. Last year we constructed pavement 9 in. thick at the edges, tapering to 6½ in. two feet from the edges with the same thickness carried across the center. This design included a longitudinal joint at the center line. We also constructed pavement having a 10 x 7 x 10 cross section similar in detail to the above. The widths were 18 and 20 ft., depending upon the volume and character of traffic to be served.

This year we have constructed approximately 30 miles of this same type. We expect to have approximately 100 miles for construction in 1925 and so far we have learned of no reason for changing the design. There were no unusual features connected with our work during the past season.

* * *

In Missouri

By H. H. Piepmeier

Chief Engineer, Missouri State Highway Commission
Jefferson City, Mo.

There were no outstanding accomplishments in the building of concrete roads in Missouri during this past year. We have built this last year about 300 miles of concrete and 300 miles of gravel road. Our next year's program will be much larger.

We are specially fortunate in Missouri in having voted a 50% increase in our motor fees and a 2c gasoline tax. This additional revenue, together with the $60,000,000 bonds which we are now expending will enable us to expand our program considerably.

In many portions of our state we are using gravel surfacing. On all of our main trunk highways, however, we are using concrete, following the Bates road type in design.

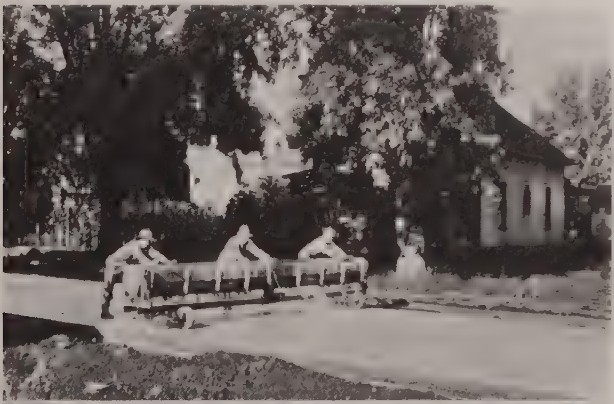
* * *

The 1924 Work in Michigan

By Frank F. Rogers

Michigan State Highway Commissioner

The year 1924 has been noteworthy in road construction. In the first place, more than 50% of the mileage of roads placed under contract were for hard surface pavements and more than 50% of the total mileage completed consisted of pavement types. Our report to November 27, which is probably not quite complete for the season, shows a total of



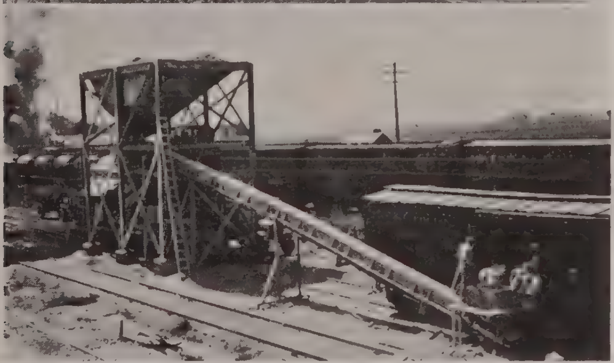


Fig. 34—Distributing calcium chloride for curing. W. C. Meneely, Route No. 2. Shelby county, Illinois

Fig. 35—Weighing aggregate, central mixing plant. C. F. Lytle, conveyor belt for cement. Woodbury county, Iowa

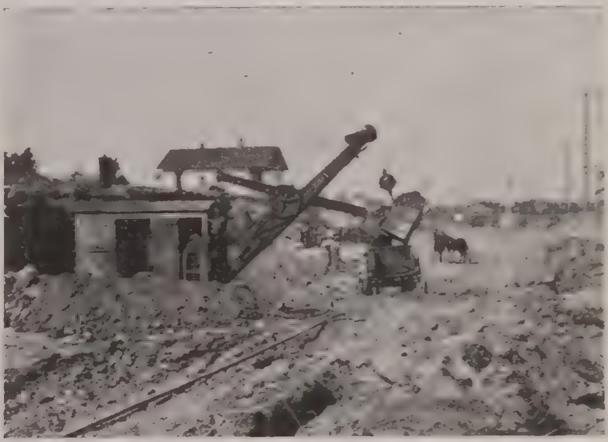
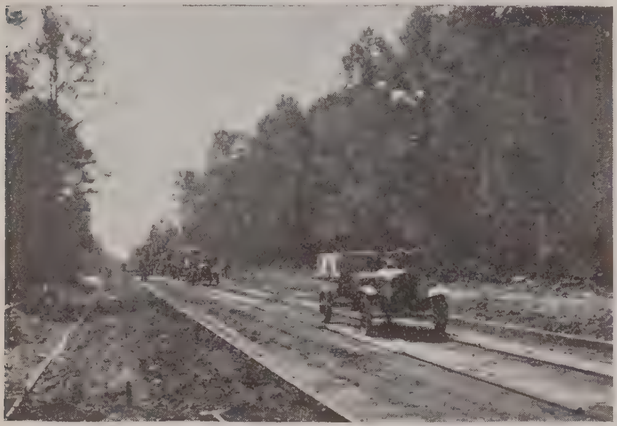


Fig. 36—Erie Shovel, Ziegler & Dalton Construction Co., State Highway, Guilford county, N. C.

Fig. 37—Proportioning plant on same job

more than 825 miles of roads of all classes and more than 457 miles of concrete and asphalt pavement constructed in 1924. While in 1922 the total mileage of completed projects surpassed this years results, the total mileage of pavements completed in 1924 surpasses that of any previous year by more than 200 miles.

In design we believe that we have taken a step forward by adopting a cross section for concrete pavements and for concrete base for asphalt top pavements, with an edge thickness greater than the center thickness to compensate for the natural weakness at the edges of the slab. Our standard concrete pavement design for primary trunk line roads with ordinary soil conditions calls for a width of 20 ft., a center thickness of 7 in. extending to within 3 ft. of the edge and increasing from that point to a thickness of 9 in. at the edge. Where traffic is unusually heavy and soil conditions unfavorable, we increase both center and edge thickness 1 in., while in the sandy soils of the resort regions in the northern part of the lower peninsula we decrease the center thickness to 6 in.



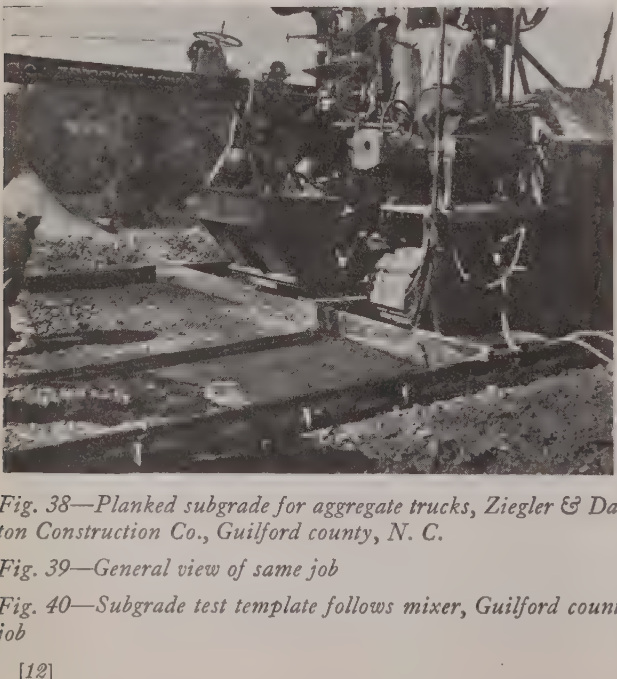


Fig. 38—Planked subgrade for aggregate trucks, Ziegler & Dalton Construction Co., Guilford county, N. C.

Fig. 39—General view of same job

Fig. 40—Subgrade test template follows mixer, Guilford county job

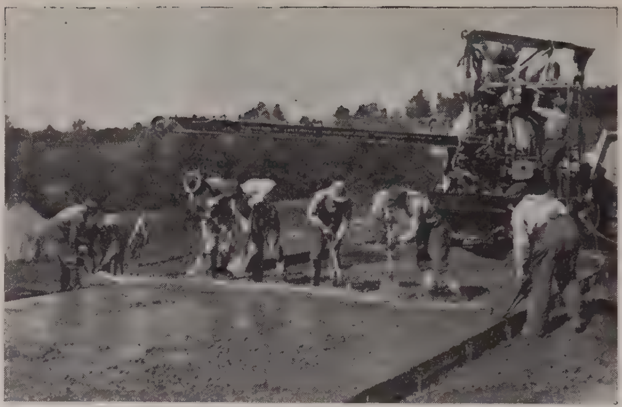


Fig. 41—Four men spade concrete ahead of steel strike-off on Guilford county job

While we formerly used a uniform thickness of slab and depended on reinforcing bars in the edges of the slab for greater strength we consider the 1924 standard both more economical and more satisfactory.

The 1924 standard also called for 1 in. transverse expansion joints spaced 100 ft. apart in all concrete pavements, regardless of the time of year in which the pavement was poured. The results indicate that this design is satisfactory and a considerable improvement over any other method of placing expansion joints so far tried out. The use of the center longitudinal construction joint has been continued and we are convinced that the introduction of this feature was one of the most important steps in the design of concrete pavements, as it has practically eliminated the longitudinal cracks which marred the appearance and lessened the strength of monolithic slabs as commonly constructed previous to 1923.

Another point of advancement in 1924 construction worthy of note is that of pavement finish. The use of the 10 ft. straight edge has been insisted upon on all pavement jobs and the smoothness of the pavements has materially improved over that of any previous year. The smoothness of finish not only improves the riding qualities of the road but also insures longer life to the pavement as it lessens impact and insures longer life to vehicles as it lessens vibration.

Along with the improvements in the slab design, in 1924 we adopted the policy of building wider grades on all of the primary trunk lines, and of securing sufficient right of way to provide for both present and future anticipated needs of the highways. On the heavy duty primary lines a shoulder width of 8 ft. each side of the pavement slab has been adopted while on the roads with less proportionate truck traffic a shoulder width of 6 ft. has been adopted, which will provide ample room for passing in cases of emergency and for parking vehicles on the shoulders to comply with the statute which prohibits parking on the pavement. It is probably true that the grade is the most permanent part of road construction and as it is generally far less expensive than the pavement itself, it is considered essential to have the grade sufficiently wide to meet all requirements.

Immediately after a road is paved the abutting property is ordinarily improved—so much so that securing additional right of way for future traffic requirements becomes a serious problem unless the future requirements are foreseen and the necessary right of way is secured before the roads are paved. On the other hand, if the necessary right of way is secured before a pavement is constructed the cost is comparatively little in ordinary cases and for this reason a definite policy has been adopted to secure the necessary additional width of right of way at the earliest possible moment in order to insure room for future expansion without future right of way costs.

In 1925 we hope to proceed along the same lines, both in policy and in design, as adopted in 1924. With the experience of 1924 and former years behind us, we hope to be able to secure even better results in smoothness of surface and in adapting our pavement and grade design to the traffic requirements of the particular roads to be improved.

Among the noteworthy jobs completed during 1924 might be mentioned—Grand River road from Farmington to Lansing constructed largely by prison labor—a 20-ft. concrete pavement with a 36-ft. grade, approximately 50 miles in length. The new Dixie Highway from the Ohio State line to Monroe and northward was built by prison labor. This is a 20-ft. concrete pavement with a 56-ft. grade with provision to widen the slab to 40 ft. in the future. This road will take care of the extremely heavy traffic between Toledo and Detroit and relieves a very serious and dangerous condition that existed on the old and narrow road.

Another road project worthy of note is Woodward Avenue between Detroit and Pontiac. For years this road was hopelessly inadequate to handle the traffic with narrow pavement and narrow right of way occupied by the interurban lines and partly narrowed down by the location of the Grand Trunk Railway lines. Due to this congestion the loss of life and property damage on this road reached an alarming proportion and while the cost of improving the road was bound to be high, any delay in construction would simply increase the cost and increase the obstacles to overcome.

Plans for the improvement of this road provided for a 204 ft. right of way and ultimately two 40-ft. pavements carrying one way traffic with a space between the slabs for the interurban lines. During the season of 1924 there were placed under contract approximately 11.7 miles of pavement varying from 20 ft. to 40 ft. in width and of this length 3.3 miles were completed and placed in use. The traffic congestion has already been greatly relieved and it is hoped that the balance of at least one line of pavement can be completed in 1925.

Changes in the Cost of Living

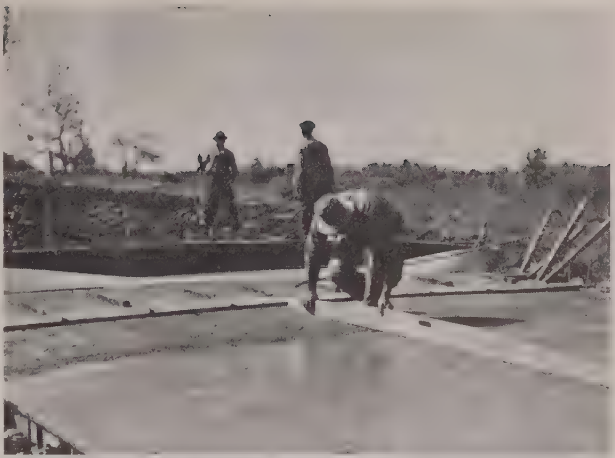
According to a comprehensive survey of the cost of living in the United States for November 15, 1924, just completed by the National Industrial Conference Board, the weighted increase of all items combined was only one-tenth of one per cent between October 15, and November 15, 1924. All of the separate items included in the cost of living showed variations in this period.

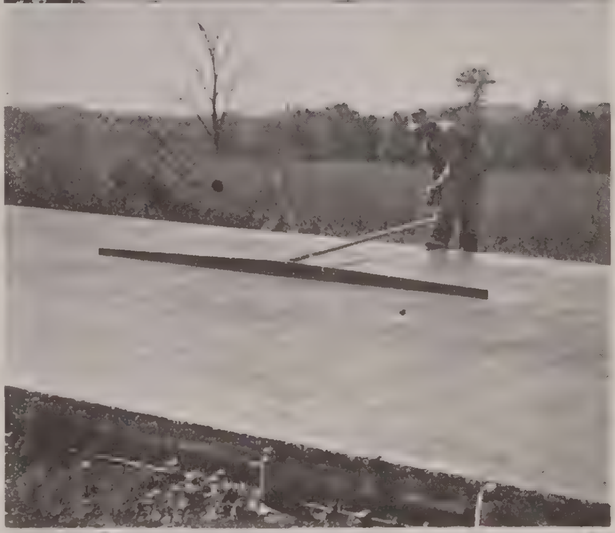
Between July 15, and November 15, 1924, there was an average increase of 2.2% in the cost of living. This change was occasioned by increases in the average cost of food, clothing, fuel and sundries, and a decrease in the average cost of shelter. The average cost of light, which had been slightly lower during this period, had returned in November to the level of July, 1924.

Between July, 1920, when the peak of the rise in the cost of living since 1914 was reached, and November, 1924, the cost of living decreased 19.2%. The increase in the cost of living since 1914 was 65.2%.

Concrete Block Fire Test Report

The National Fire Council, which reviews and approves all reports by the Underwriters' Laboratories before they are made public, has passed favorably on the report of the concrete block fire tests recently made under the joint auspices of the American Concrete Institute, Concrete Products Association and the Portland Cement Association. The recommendations of the Underwriters' Laboratories, drafted for the guidance of the various insurance rating bureaus, have been concurred in without change by the fire council, and should be useful in efforts to obtain rate adjustments more advantageous to concrete building units. The report has been published and is being distributed by the Institute and the Portland Cement Association.





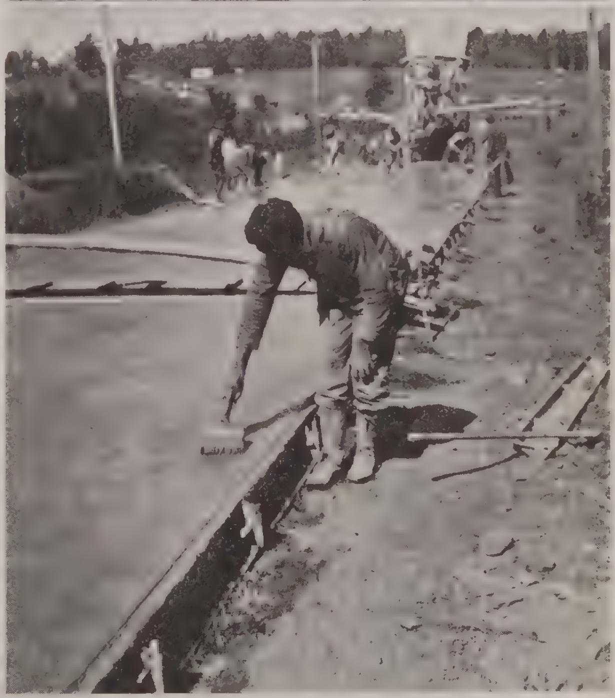


Fig. 42—Straight edging construction joints, Guilford county work

Fig. 43—Using long handled straight edge, Guilford county, N. C.

Fig. 44—A refinement in finishing—brushing out float marks on Guilford county job

Future Building Prospects

In pointing out some facts and figures relative to the construction industry during the past few years, and in answer to the question, "What of the future of building," Morton C. Tuttle, a construction engineer, urges prompt action. The following excerpts from Mr. Tuttle's article, together with a chart showing the volume of building contracts in 27 Northeastern states as published in the *Boston Evening Transcript*, contains information of interest to craftsmen and laymen alike.

Figures are a splendid confirmation of an opinion, but are likely to seem less impressive as they conflict with preconceived judgments. Often impressions gathered from daily experience and general observation parallel statistics and under such conditions it is easy to reach a conclusion as to future probabilities.

At the present time general facts in regard to the building trade are readily ascertainable and figures correspond fairly closely with general impressions. Accordingly, it seems possible to reason, using the minimum of statistical information, and reach rather definite conclusions as to prices and activities which will develop in the building trade during the next few months.

That there was a rapid decline in the total volume of building beginning shortly after January, 1920, is shown by graphs and figures printed in "A Survey of Current Business," published by the United States Chamber of Commerce. This decline reached the bottom about January, 1921. There was also a gradual improvement during that year, with a rapid expansion in the building industry in the early months of 1922. Since then the volume of building has remained on a fairly high level until the middle of 1923, when the volume dropped to about the low point for the year 1922. The fact to be noted is that during the past two years the building trade has been fairly active.

We will consider the problem of future activity and accordingly the cost of future construction. It is an obvious fact that there has been a tremendous shortage of housing. While "To Let" signs may be observed in many suburbs, house-building has continued during this fall. Nearly everyone has heard discussions among his friends of proposed home-building for the coming year. Apartment houses are going up, and whatever statistics may show, there seems to be the promise of a large amount of residential construction for the coming year.

Statistics of the building situation are more numerous than definite and one can find figures to prove that a large part of the building shortage has been satisfied, that some industries have been over-built, that road building and building of public works have reached the point where the tax-payer will refuse to go on. On the other hand, there are statistics that indicate there is an accumulated shortage of building equal to two years output of the entire building trade.

The observed facts are: that there continues to be a large amount of house-building; that many industries require new buildings; that road work with its accompanying bridge construction is planned to a large extent; that there is an unfilled demand for hospital facilities, police stations and the usual city and Government work; that power plant construction is being projected in volume. The increasing popularity of public service securities is based partly on the fact that great economies can be effected by centralizing the generation of electric energy into large units. This has resulted in a tremendous amount of power plant construction, both steam and hydro-electric.

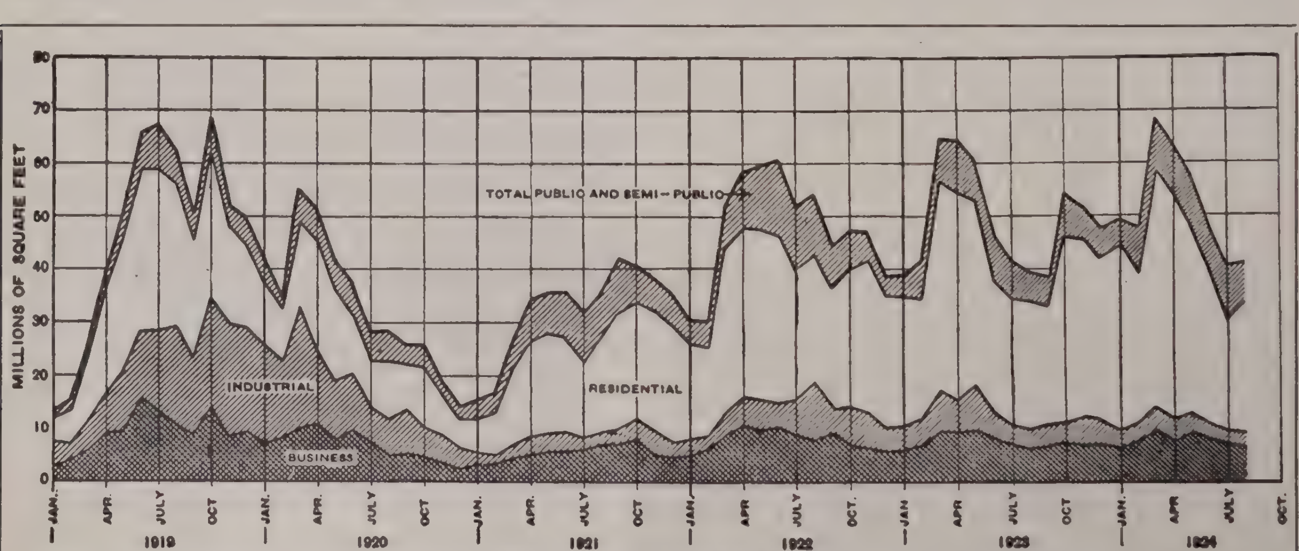
The sweep of optimism following the election has come at a time of cheap money, a time especially suitable for the financing of building operations. It seems reasonable to believe that such a combination of circumstances following a period of delayed industrial construction forecasts increased volume of this type of work. This is precisely what is indicated by the release at this time of numerous projects which have up to now been tentative only and are now labelled "rush."

If it is assumed that there is to be prosperity in general business and an increase in building operations, consideration must be given to the fact that the irregular curve of employment in the building trade makes it dependent upon the floating supply of labor which is also available for industry at large. Accordingly, the building trade meets competition for labor supply which formerly was secured from immigration. The existence of a limited labor supply results in fluctuation of wages. Recognition must be given to the fact that at present the building trades are better organized and an abnormal increase in the volume of work is likely to be followed by the familiar decrease in output and later increase in wages. The optimism which encourages the buyer of buildings also encourages the manufacturer and dealer in building supplies. This means they will try for higher prices.

There is a growing belief by those in a position to judge that there will be a noticeable increase in the volume of construction and engineering work during the coming spring and early summer. If this develops, anyone confronted with the necessity of building during the summer of 1925 is likely to look back regretfully on the winter months now before us. The material market has not felt an extreme demand for its product, and labor is still plentiful and accordingly efficient. Winter months are the seasonably low spots in prices of building materials and contracts for materials and services can be placed at better figures, comparatively, than at any other time during the year. Anyone believing that the coming year is to be one of prosperity for the manufacturing industry will probably conclude that this prosperity will be attended by added demands on an already busy building trade, resulting in higher prices. Therefore, it will be profitable for those contemplating building within a period of the next year or eighteen months to consider the advisability of prompt action in getting design and building operations under way.

Sharing Management with Workers

A partnership plan which gives the employes of an industrial property a share in management and profits, equal in many respects to that enjoyed by the owners, is suggested for the consideration of industry generally in a report on "Sharing Management with the Workers," issued by the Russell Sage Foundation. The report is based on a study of the Partnership Plan of the Dutchess Bleachery, Inc., at Wappingers Falls, New York, which, in the opinion of Mary Van Kleeck, Director of the Department of Industrial Studies of the Foundation, is "one of the most significant of the several hundred current experiments in giving workmen a share in the management of business."



Graph showing volume of building contracts awarded in 27 Northeastern states

The story of a twelfth century castle that was not torn down

Of Dobson—A Contractor Who Tried

The Reminiscence of a Wrecking Job, Minus Modern Methods

By H. G. Badder
London, England

THE reader with seasonable leisure after a year's hard work, may be able to raise a smile over the troubles of some other man with that stony mixture, Concrete, in his efforts to win a few dollars so as to run a home and keep up a prosperous appearance.

No doubt after reading this story of one man's efforts, he will meditate awhile and decide how he would tackle the job and win out. Yes! It's a fairly easy job now, but fifty years or more ago the tools were mostly brute strength, a few pinch bar levers and ropes.

And if the reader did succeed expeditiously, in taking down such a tower as the rubble one in this episode, his methods may seem very crude fifty years hence to the man who will then make a few electrical connections round such a tower, move a lever, and see the walls gently fall inwards to a heap of spoil ready to feed into a crusher.

The following little history is told with illustrative proof that can be authenticated; and to get the moral out of the way beforehand instead of at the end, it is this: "Don't bite off more than you can chew."

The southeastern corner of England is named the County of Kent, and an epitome of its history is that of all England. Here Caesar invaded Britain. Saint Augustine landed to preach the gospel in A. D. 597, and a warlike Bishop named Gundulf commended the building of a Castle at Rochester on the Medway in A. D. 1077, which was finished by Archbishop Corbeil in A. D. 1126, and he was made Constable of the Castle by King Henry III to hold it for the Crown.

The Castle was granted in A. D. 1610 by King James to Sir Anthony Weldon of Swanscombe—where now-a-days, portland cement is made—and Sir Anthony's descendants held it until 1883.

The Castle keep, a massive structure 70 ft. square and 120 ft. high to the top of the turrets, had walls 15 ft. thick at the base and 10 ft. thick at the top of the keep, and there are inside cross walls 5 ft. thick. The various floors were formed of hard thick timber supported by great beams of timber, a forerunner of mill construction for fire resistance.

There are of course, many types of construction, Roman, hard as a rock, then Gundulf's beside and above it, then again King Henry's work, the last two not so strong as the first. Military sieges and mines under the walls did some

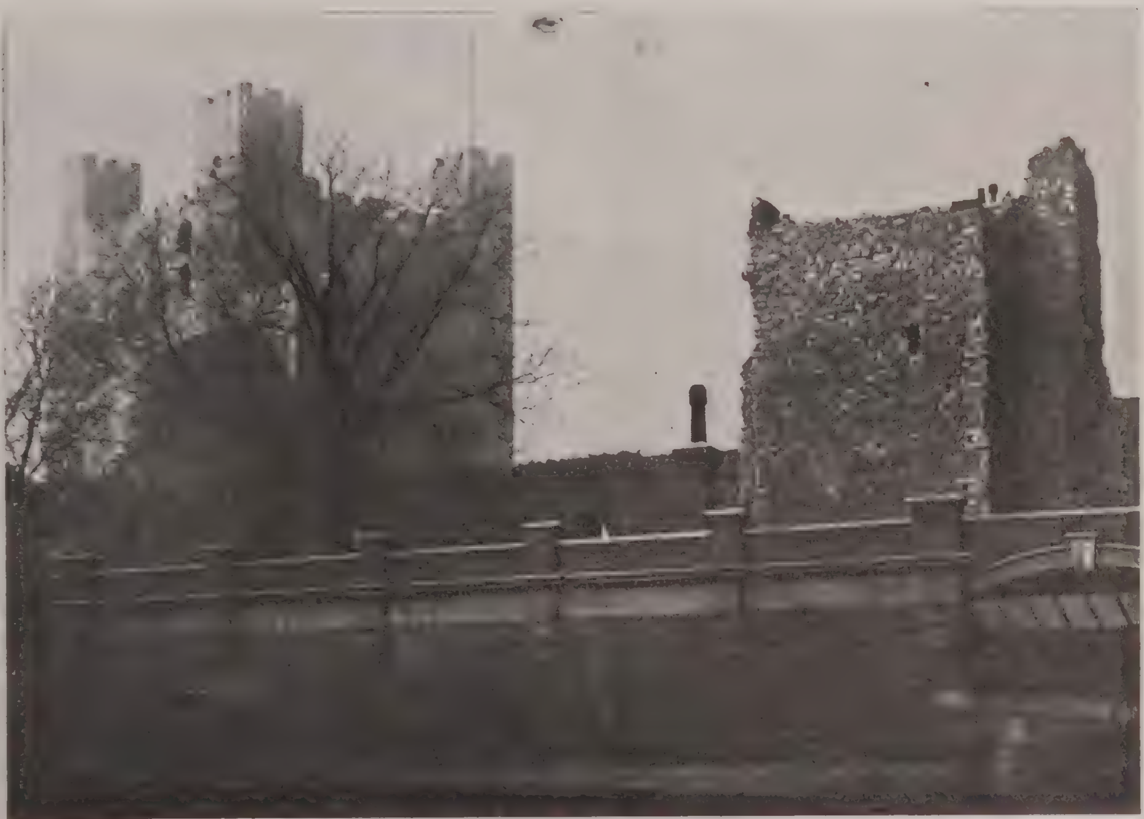


Fig. 1—Rochester Castle. A general view of the castle, showing an angle turret to curtain walls, and a new road with embankment walls

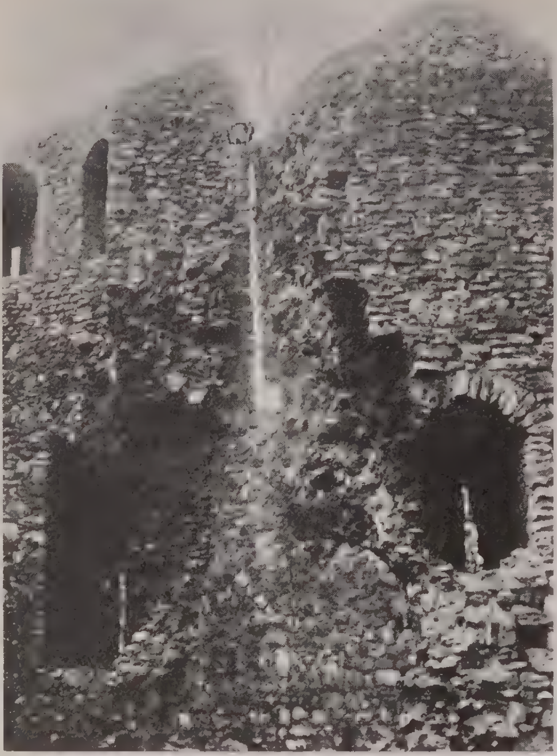


Fig. 2—An unrepaired breach made in curtain walls during a military siege

damage, but these were repaired by King Edward III, in A. D. 1268

At last, silent and deserted, it stood defying time and storm into the early years of the nineteenth century, when a wave of destrictive vandalism swept over England. A descendant of Sir Anthony Weldon, who loved money rather than archeology, felt free to have the great Castle pulled down to use as building materials.

He called in Dobson, a contractor, to whom he explained his scheme.

"I reckon there will be enough stone to build a good wall and bank to the river around my land," he explained, "if you will go into the cost of carting the old stone, and building the wall and bank, I will see what I can do."

In a few days Dobson had his estimate, and after some bargaining they agreed upon a price for the work.

"Now what do you think it will cost to pull down the Castle?" enquired the owner.

Dobson ruminated over the question while stroking his beard.

"Well, I reckon it can be done, all round, at a penny a cube foot,—ready for carting, that is."

"Jupiter!" exclaimed the owner, "There's tens of thousands of cube feet in those walls,—I want a lump sum price for pulling it all down. You had better measure it, but don't gossip about it," he warned.

So Dobson took a boy with him, and fussed about the castle walls measuring up for a couple of days, then called upon the owner again.

"Them walls be thick, sir," said Dobson, "It measures 360,000 cube feet of walls and floors,—I don't think it can be done for less than fifteen hundred pounds."

"I'll never pay that!" exclaimed the owner, "Why my friends think it can be done for almost nothing."

"Yes, maybe," Dobson replied, 'but then they expect the man that pulls it down can use or sell the stone he wins out of it—you can't have the stone for your walls for nothing."

The owner saw the point, and finally argued Dobson into cutting his price, and enter into a contract to complete the work between Whitsun and Christmas days.

Within a week, Dobson took his men to the work, and with Rafferty, his foreman, climed the rough stairway to the top of the keep. The wonderful view did not interest them. Both were planning the best way to get the work done.

" 'Tis a great job sorr," warned Rafferty. "We'll be having trouble wid the men up here right off."

"It will be easy enough," declared Mr. Dobson, "you can work on a scaffold fixed from the floor inside, and use iron wedges to split the wall into large rubble so it can be built into new walls."

"Aye, aye, sor," replied Rafferty who has followed the sea. "The men will get their hand in in the course of a day or so. Come on lads! We'll fix a hoist for to get the scaffold up and get to work."

Mr. Dobson climbed the high stairway again toward the end of the week because not one cart of stone had come down from the keep.

"What are you doing here, Rafferty, sucking your pipe?" he demanded.

"Divil-a-bit!" retorted his foreman bitterly. "We been belting wedges till they bent. Look at that, sorr," showing his employer a long iron wedge with a crushed head and point. " 'Tis a machine ye'll be needing for this work. Look at me hands!"

Calloused as Rafferty's hands had been with long years of hard work on sea and land, they were now split and raw with his efforts to drive wedges into the centuries old concrete, to encourage his men by his example, they too held out their hands without remark.

" 'Tis iron hard, or harder," wailed Rafferty. " 'Twould break any man's heart. Sure it's the sea air and the winds that's made it so. I've seen none like it in my work."

Mr. Dobson was alarmed. "I can't put machinery up here, isn't there something else we can do to make the work easier."

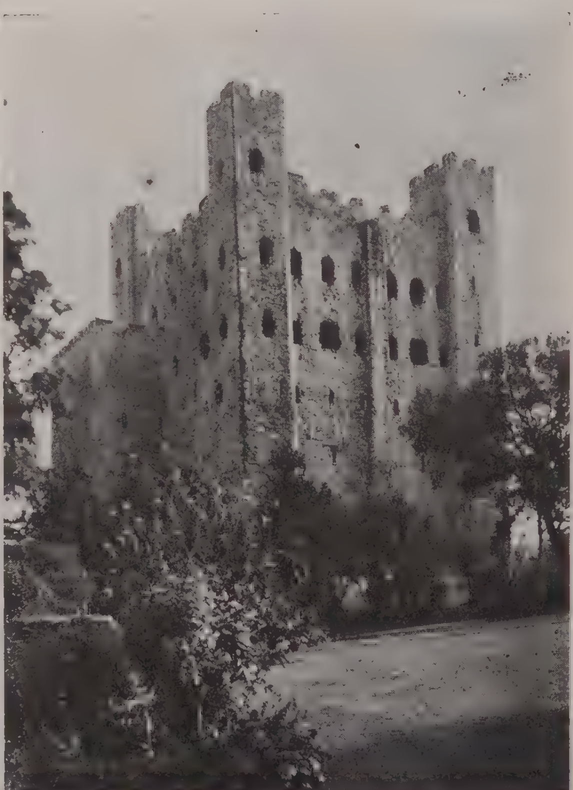


Fig. 3—A specia view of the castle keep, showing attempts at top to break down the walls between turrets

"Well, sorr, ye might use gun powder and blow it out in pieces," suggested Rafferty.

"No, No, we can't do that. Some pieces might fall outside and break something or kill somebody. I can't afford to pay any damages," replied Mr. Dobson, now thoroughly dismayed.

"I've seen lime cartridges used sorr, they don't make any noise and just split the stone without moving it," proposed Rafferty, hopefully.

Mr. Dobson meditated while stroking his beard. "Very well, Rafferty. Send a man to my house to get an order for cartridges from the lime works, and you get fixed to use them, but take care not to do any damage," he finished authoritatively, as he turned to depart.

Rafferty was a trier. He started his men to make bore holes on the inside of the wall, about eighteen inches below the top. Then he rigged up a hanging cradle over the outside wall so that cartridges placed there would cause the pieces to fall inwards when the lime exerted pressure. He hitched his belt another hole tighter before going over into the cradle himself.

A hundred feet in the air he sat astride, to punch out a bore hole, turning his chisel vigorously to drive and cut in. It was slow work and took him hours to get deep enough for a trial.

Early Saturday morning he set his lime cartridges using hard wood plugs with iron wedges to tighten them in the mouth of the bore holes. Nothing happened before evening. When the men's time was up, he sent them to Dobson's house for their wages, retaining one man with him until the cartridges acted.

Time passed, both men were mooning over their pipes, but it was still light. Suddenly the laborer yelled and fell over. A plug had blown out, that, striking his leg had knocked him over. "Heaven's be!" muttered Rafferty, as he saw the lime oozing out of the bore hole. "Gun powder wouldn't shift them walls. Get up ye fool!" he roared at the man moaning on the floor. "Sure the next one will be hitting yer stummick if ye lay there. Come up beside me above the blasts!"

All the cartridges but one blew out their plugs, and that one either failed or acted upon some internal cavity. No outward result was visible in the form of cracks or spalling of the stone.

"I'm beat!" growled Rafferty. " 'Tis myself will be looking for a new job next week."

Mr. Dobson was beat too. He tried other methods but found them so costly he gave up trying.

The owner was beat too. He lost his cheap wall and a cleared site, but he did get something. That was the thick hardwood floors and beams. Also he died before he could use the timber.

Then public opinion changed. Castles were now to be preserved as historic treasures. The City Fathers of Rochester purchased the Castle and grounds from the Earl of Jersey in A. D. 1883.

Subsequently the City Fathers laid out the grounds for public recreation, but they fixed a charge for admission to the Castle.

Charles Dickens laid the scenes he wrote of in "The Mystery of Edwin Drood" around the quaint streets of Rochester in Kent.

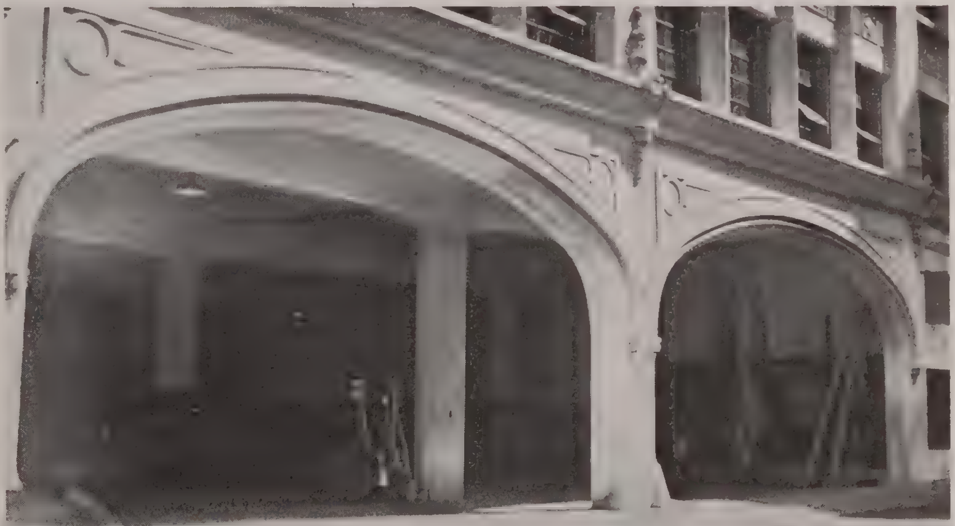


Fig. 1—Wide entrances to front of reinforced concrete garage

Wide Entrances for Concrete Garages

Nothing is so discomforting to a motor car owner as to have to remain outside of a service building or garage amid other motorists, all of whom are trying to crowd through a narrow doorway.

One of the first features of the Palace concrete garage in San Francisco to attract attention is the wide entrances. They are too large to be called doorways. There is absolutely no cause for blockades or delays of cars entering or leaving the garage and no danger of cars running into each other, as there is plenty of room to turn.

The wide entrances are 18 ft. high and have a 25-ft. clearance. In reality, there are no arches over the wide entrance, but a continuous beam with architectural effect below, carried by the beam by means of extended stirrups of reinforcing steel. The reason arches were not actually used was because of the danger of earthquakes to such construction wherein the shoulders of an arch may be moved out of place. The type of construction illustrated is not so subject to damage by earthquake shock.

How proportions are upset by wet sand

The Effect of Moisture in Sands in Proportioning Concrete Mixtures

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The object of proportioning water, cement, fine and coarse aggregate in a concrete mixture is to place in it definite amounts of each. Extensive laboratory research has established that definite proportions of all these ingredients (including the water) are fundamental to uniform quality and strength in concrete. In the laboratory, aggregates are measured "dry and rodded," in which condition a cubic foot of an aggregate has a practically constant weight. Proportions in which the aggregates are measured "dry and rodded" will therefore insure definite amounts of each in the mixture.

Aggregates in the field are piled loose, usually damp and at times, wet. It is common practice to measure the aggregates damp and loose from the piles. Every engineer, inspector or foreman on a concrete job has observed that moisture in sand caused it to bulk or increase in volume, while it has practically no effect on the volume of coarse aggregate. At the same time it was no doubt observed that proportions which gave concrete of the desired workability one day with one lot of aggregates, gave concrete that was harsh and difficult to handle another day. It was not uncommon to lay the trouble to the moisture in the sand but the magnitude of the effect of the moisture was by no means clearly understood.

An experiment was accordingly planned which would show the effect of moisture in sand. In order that the experiment might be sufficiently general, three sands were used viz., a coarse sand graded from 0 to ¼ in. and desingated as 0-No. 4, a medium sand graded from 0 to ⅛ in. and designated as 0-No. 8, and a fine sand graded from 0 to 1/48 in. and designated as 0-No. 48. Each was thoroughly dried before the experiment began and varying amounts of moisture added to successive samples of equal weight of each sand. These samples were then placed in glass hydrometer jars and photographed. Figs. 1, 2 and 3 show the effect of moisture and loose measurement on coarse, medium and fine sand respectively. The procedure in showing the effect of moisture in each grading of sand is explained in the following paragraphs in order that Figs. 1, 2 and 3 may be clearly understood.

Nine samples of equal weight were taken from each sand. As previously mentioned, a given weight of an aggregate in a "dry, rodded" condition occupies a practically constant volume. One of the samples was accordingly "dry, rodded" into jar No. 1 to establish a definite standard with which to compare volumes of the same weight of sand in the other jars. This sample was placed in jar No. 1 in three approximately equal layers, each layer being rodded 30 times with a ¼-in. rod, and the top of the sand leveled off. Another sample of dry sand was then placed, a scoopful at a time, in jar No. 2. This jar then contained dry, loose sand, which accordingly occupied a slightly greater volume than the "dry, rodded" sand in jar No. 1.

Jars 3 to 6 inclusive were filled with samples of sand to which had been added 1, 2½, 5, 7½, 10, and 15% of moisture (by weight of dry sand). Jar No. 9 was filled with sand containing slightly more moisture than was required for saturation. This amount varied for the three grades of sand.

Referring to Figs. 1, 2 and 3, it will be noted that up to 5% of moisture the sands continued to increase in volume. This increase in volume amounted to 40% of the "dry, rodded" volume of the coarse sand and to 52% of the "dry, rodded" volume of the fine sand. Beyond this there was a gradual decrease until at saturation the volume was nearly the same as that in a "dry, rodded" condition.

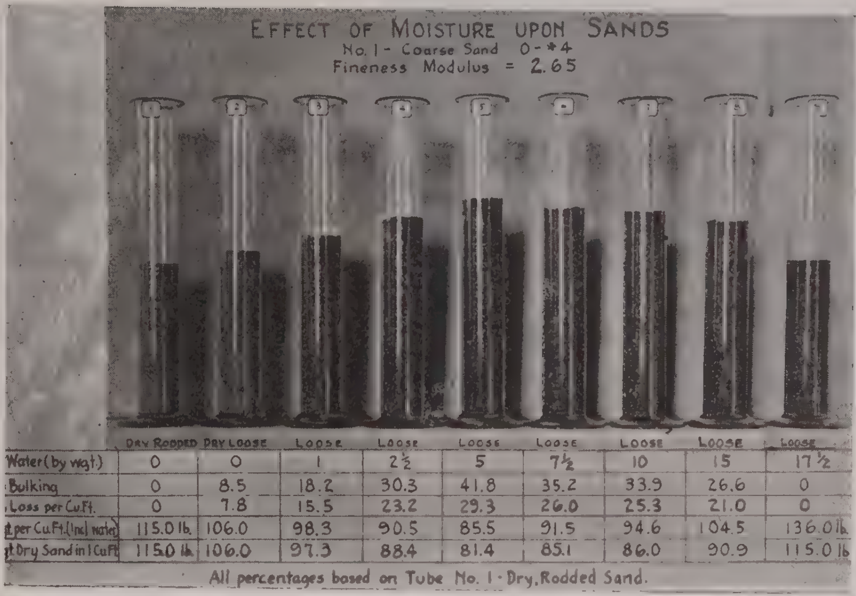
In order that differences in volume might be distinctly evident, jars whose heights were several times their diameters were used. This resulted in a comparatively large glass area for the volume of sand and as the sands became successively wetter, there was a greater tendency for the sand to stick to the glass and not settle as much as it would under conditions of field measurement. A comparison of the bulking due to moisture as measured in these tests with that measured in containers recommended for field use whose heights and diameters are approximately equal, shows the former to be approximately 10% higher.

The important lesson to be gained from Figs. 1, 2 and 3 is that the actual amount of sand in 1 cu. ft. of damp sand measured loose, varies within wide limits. Using the values from Fig. 1 for illustration, it will be seen that while 1 cu. ft. of sand in a "dry, rodded" condition weighs 115 lbs., yet the weight of dry sand in 1 cu. ft. measured loose and containing 5% of moisture is but 81.4 lbs. Thus 33.6 lbs. or 29.3% of the sand was lost by measuring it damp and loose. Field tests show that a moisture content of 5% in sand is quite common. Where proportions are expressed by volume, as 1:2:4, the actual amount of sand in a 1-bag batch may vary by 67.2 lbs. depending on whether the sand is measured in a "dry, rodded" condition or in a loose condition with a moisture content of 5%. While the volume of the coarse aggregate is not affected noticeably by the moisture, it compacts from 7 to 15% upon rodding. A 1:2:4 mix, where the aggregates are measured "dry and rodded," in reality approximates a 1:1.4:3.6, where the aggregates, containing 5% moisture are measured loose. It will be apparent that proportions very different from those intended will be used unless proper correction is made for the effect of moisture in the fine aggregate. The mix will be definitely under-sanded.

The correction for bulking in sand caused by moisture is easily made. As aggregates have standard volumes only when "dry, rodded," proportions should be used in which the volumes of the aggregates are given in a "dry, rodded" condition. It is then merely necessary to determine how much sand measured damp and loose is necessary to make 1 cu. cu. ft. in a "dry, rodded" condition, and similarly for the coarse aggregate. These weights are determined on the job and the proportions revised to comply with field conditions.

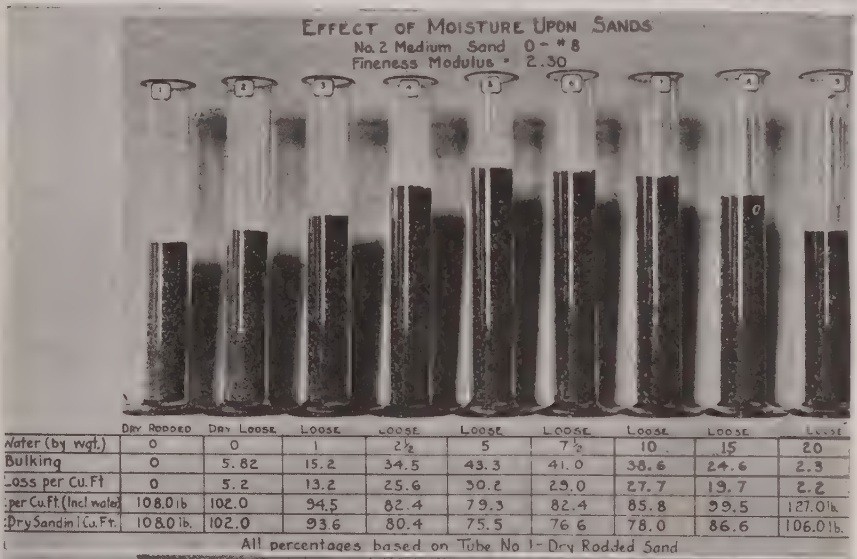
Because of the bulking of sand when damp, some prefer to use proportions by weight. Where such is the case it is obvious that the weight of aggregates should be determined in a "dry, rodded" condition in order that they may be standard. With proportions so expressed it is merely necessary to use enough additional sand and coarse aggregate to compensate for the weight of moisture contained. Simple

These Pictures Show the Necessity for Correction of Proportions When Sand Is Wet


EFFECT OF MOISTURE UPON SANDS
No. 1 - Coarse Sand 0 - #4
Fineness Modulus = 2.65

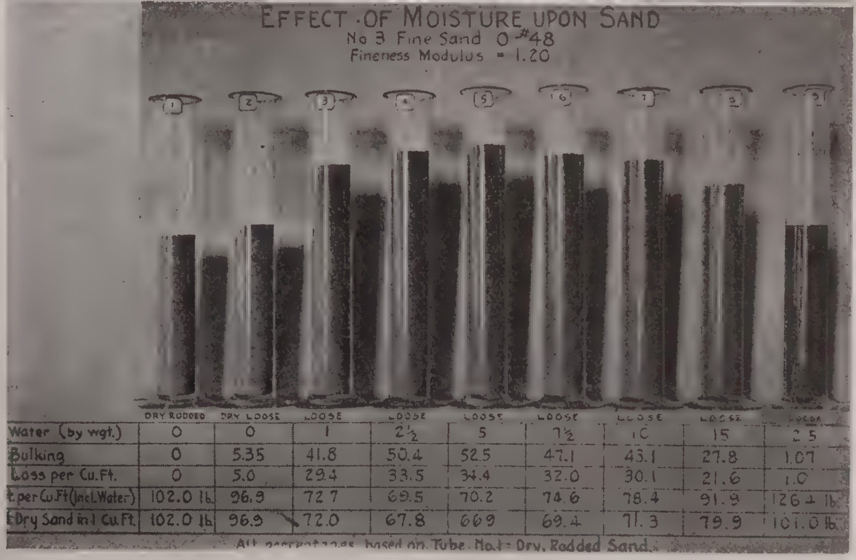
	DRY RODDED	DRY LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE
Water (by wgt.)	0	0	1	2½	5	7½	10	15	17½
Bulking	0	8.5	18.2	30.3	41.8	35.2	33.9	26.6	0
Loss per Cu.Ft.	0	7.8	15.5	23.2	29.3	26.0	25.3	21.0	0
t per Cu.Ft.(Incl water)	115.0 lb.	106.0	98.3	90.5	85.5	91.5	94.6	104.5	136.0 lb.
t Dry Sand in 1 Cu.Ft.	115.0 lb.	106.0	97.3	88.4	81.4	85.1	86.0	90.9	115.0 lb.

All percentages based on Tube No. 1 - Dry, Rodded Sand.


EFFECT OF MOISTURE UPON SANDS
No. 2 Medium Sand 0 - #8
Fineness Modulus = 2.30

	DRY RODDED	DRY LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE
ater (by wgt.)	0	0	1	2½	5	7½	10	15	20
Bulking	0	5.82	15.2	34.5	43.3	41.0	38.6	24.6	2.3
oss per Cu.Ft	0	5.2	13.2	25.6	30.2	29.0	27.7	19.7	2.2
per Cu.Ft.(Incl water)	108.0 lb	102.0	94.5	82.4	79.3	82.4	85.8	99.5	127.0 lb.
Dry Sand in 1 Cu.Ft.	108.0 lb.	102.0	93.6	80.4	75.5	76.6	78.0	86.6	106.0 lb.

All percentages based on Tube No 1 - Dry Rodded Sand


EFFECT OF MOISTURE UPON SAND
No 3 Fine Sand 0 #48
Fineness Modulus = 1.20

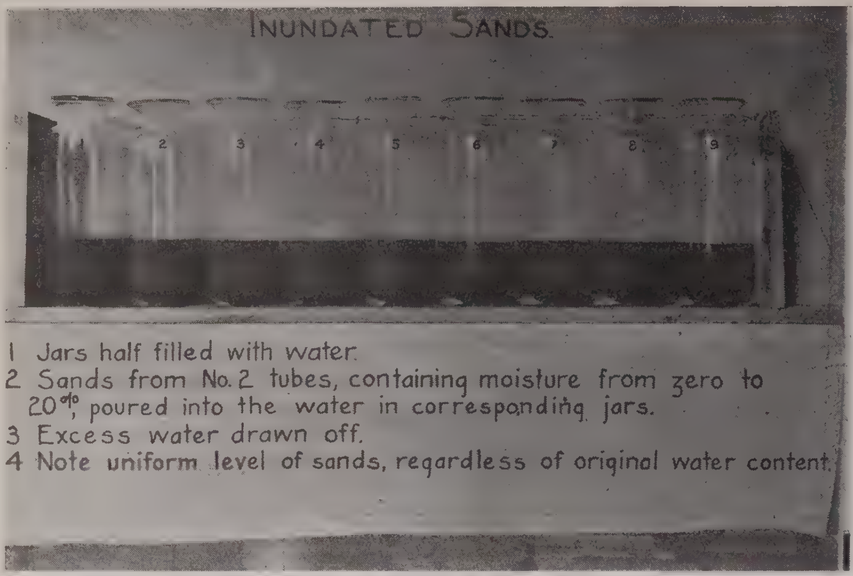
	DRY RODDED	DRY LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE	LOOSE
Water (by wgt.)	0	0	1	2½	5	7½	10	15	25
Bulking	0	5.35	41.8	50.4	52.5	47.1	43.1	27.8	1.07
Loss per Cu.Ft.	0	5.0	29.4	33.5	34.4	32.0	30.1	21.6	1.0
t. per Cu.Ft(Incl.Water)	102.0 lb.	96.9	72.7	69.5	70.2	74.6	78.4	91.9	126.2 lb.
t Dry Sand in 1 Cu.Ft.	102.0 lb.	96.9	72.0	67.8	66.9	69.4	71.3	79.9	101.0 lb.

All percentages based on Tube No. 1 - Dry, Rodded Sand.

Figs. 1-3—These illustrations demonstrate the bulking effect of moisture in sands in such a way as to bring out the remarkable effect of moisture in sands on the proportioning of concrete. It will be noted that the jars to the left and right of the illustration, namely, jars Nos. 1 and 9, have nearly the same height of sand in them, but that all other jars show the sand much higher. Knowing that all of these jars contain the same weight of sand and that the only difference is the amount of moisture contained in the sand, the effect of moisture in causing sand to bulk will be seen clearly.

It is obvious that unless the contractor takes account of the variation in volume of a given weight of sand due to the moisture content, he will have one set of proportions one day and another set of proportions another day. It is also obvious that any tables of quantities, or of proportions for that matter, which are not based on constant conditions of measurement cannot be expected to check out in actual field work.

These photographs, including Fig. 4, were taken to illustrate a set of experiments especially performed to demonstrate a necessity of making corrections for bulking of sand due to moisture and loose measurement in all proportions. These experiments are unique in that they were made primarily to bring out the relation between the volume of dry sand and moist or inundated sand. A small amount of information has already been gleaned through tests made for other purposes but these tests will be of particular interest to that constantly growing number of engineers who are studying the application of field control methods to the making of concrete.



1 Jars half filled with water.
2 Sands from No. 2 tubes, containing moisture from zero to 20%, poured into the water in corresponding jars.
3 Excess water drawn off.
4 Note uniform level of sands, regardless of original water content.

Fig. 4—The jars in this illustration contain the same weight of sand but the sand in each jar is different from that in any other jar, as to the maximum size and grading of the sand. The illustration shows, however, that regardless of the difference in the size of the sand, the volume when inundated is practically the same.

tests made on the job will determine the weight of moisture present which must be replaced by an equal weight of dry aggregate.

Another method, known as the inundation method, has been used to a limited extent to measure the fine aggregate in a concrete mixture. Sand is inundated when it is poured or shoveled into sufficient water to flood it. A simple experiment, illustrated in Fig. 4, in which the medium sand, graded from 0 to 1/8 in. in the jars in Fig. 2 was inundated, shows what happens. In the experiment all of the samples were inundated into just sufficient water to inundate the dry sample. The additional moisture in the wet samples was removed to a uniform height before the photograph was taken. Regardless of the bulking shown in Fig. 2, all samples, which it will be recalled contained the same weight of dry sand but varying amounts of moisture, have approximately the same volume when inundated. The bulking of sands due to moisture is therefore corrected automatically when measured in an inundated condition. Tests easily made will determine the relation between standard proportions in which the aggregates are measured "dry, rodded," and where the fine aggregate is measured inundated.

How 2500-lb. Concrete Becomes 500-lb. Concrete by Disregard of Five Factors

By J. H. Wasson

From a paper presented before the Detroit Engineering Society, Detroit, Mich. Dec. 19, 1924.

The following tabulation shows the resulting effect upon the strength of 2,500 lbs. concrete when the fundamental principles for making good concrete are violated.

Fundamental Principles	Extent of Violation	Effect on Comp. Strength per sq. in.	Cumulative Effect on Comp. Strength per sq. in.	Corrective Measure to be Taken
	None	2500	2500	None
Cement Content	8% low	2250	2250	More Accurate Measuring
Grading of Aggregates	40% Stone 60% Sand	1800	1600	Sieve Analysis (Fineness Modulus)
Water Content	30% excess water	1500	800	Control Consistency (make slump test)
Time of Mixing	16 sec.	1950	620	Mix one Minute (use Timer or watch)
Curing	Drying (Summer) Cold (Winter)	1850	460	Keep Moist (Warm in Winter)

The strength figures as given in the third column of the above table, are based upon tens of thousands of tests made at the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill. The cumulative effect of these defects on the strength of concrete as given in column four is also based upon the results of the same tests. However, deductions made in this column are semi-theoretical, that is in order to absolutely verify these figures it would be necessary to take various batches of concrete and deliberately and carefully violate the items in column one, starting from the top, each time violating one additional principle to the extent indicated in column two.

In 1923 the Big Four Railroad constructed a reinforced concrete bridge over the Great Miami River at Sidney, Ohio. The construction of this bridge which contained 28,000 cu. yds. of concrete, was under the direct supervision of J. B. Hunley, engineer of bridges and structures for the Big Four Railroad. Careful field control of the grading, proportioning, and consistency, was maintained throughout the construction of this bridge.

Mr. Hunley's conclusions from his experience gained on this bridge, in methods of producing uniformly high-grade concrete in the field, are as follows:

1. That the method of designing concrete mixtures, as worked out in the laboratory, is applicable under field conditions and that a concrete of predetermined strength can be obtained with considerable accuracy, by using the proper mix and consistency.
2. That quite dry concrete, of aggregates properly proportioned,

can be worked without difficulty and handled by the usual methods, and with considerable saving in cement over that necessary in the wetter mixtures of equal strength.

3. That a specification, simply defining the mix as 1:2:4 and 1:3:6, etc., without establishing some further requirement as to the consistency and grading of the aggregates, means little from the standpoint of strength as the results may vary 100% and consequently such a specification is uneconomical.

4. That better results can usually be obtained with concrete made from separate aggregates (sand and stone) than from a premixed aggregate (gravel).

5. That unless inspectors who are familiar with this method of proportioning concrete are available, it is scarcely practicable on small work as it takes them some little time to learn the mechanics of the tests, and longer to completely grasp the theory, so as to be able intelligently to vary the mix under the different conditions of weather, material and pouring; where frequent sieve analysis and slump tests are made it requires a good deal of the inspector's time, and on large and important work a special man to make the necessary tests would probably be justified.

Partial List of Projects on Which Scientific Methods of Control in Making Concrete Have Been Used

Queenstown Chippewa development, Niagara Falls, Ont., Can.; Canada Cement Co., Ltd. Office Bldg. Montreal, Que., Can; Great Miami River bridge, C. C. C. & St. L. Ry. Sidney, Ohio; Hide & Leather Realty Bldg., New York City; Victor Talking Machine Co., Bldg., Camden, N. J.; Aqueduct, Great Falls, Va. to Washington, D. C.; Tribune Tower, Chicago, Ill.; State Highway Dept., Utah; State Highway Dept., Nevada; U. S. Navy at Mare Island Navy Yard, Calif.; Jamaica Bay Blvd. Borough of Queens, New York City; Memorial Stadium, University of Illinois, Urbana, Ill.; Precast slabs, railway track paving, Salt Lake & Utah Ry. Co., Utah; Concrete foundation, power house, Detroit Edison Co., Detroit, Mich.; Concrete streets, Athens, Ga.; Dort Motor Co. plant, Flint, Mich.; Delaware River bridge, near Philadelphia, Pa.; San Francisco Chronicle Bldg., San Francisco, Calif.; Polo Grounds Stadium, New York City; Ward Baking Co. Bldg., New York City; R. H. Macy Warehouse, New York City; New York Telephone Co., Brooklyn, N. Y.; New York Telephone Co., New York City; C. R. R. of N. J. bridge across Newark Bay between Elizabeth and Bayonne, N. J.; Iowa State Highway Dept.; Lyman & Richey, Sand & Gravel Co., Omaha, Nebr.; Waterworks Dept. City of Montreal, Que., Can.

In the construction of Beck's Run Bridge near Pittsburgh, the Pennsylvania R. R. is making field tests for the control of the concrete. Testing is carried on continuously during concreting and each car of sand is sampled at different depths and places and sieved to obtain the representative fineness modulus. Samples are also dried from time to time and the proportions adjusted for the bulking effect of moisture and loose measurement. The slump is held to 4 in.

The bridge department of the Western Region of the Canadian National Railways is designing the mix for all concrete used. Special instructions have been issued in regard to the methods to be followed and during the construction season, engineers especially qualified are kept on the road in constant touch with all concrete projects. Colorimetric tests and sieve analyses are made on all aggregates and the slump test is strictly adhered to.

In the construction of the large cylindrical piers for the Lousiville & Nashville R. R. bridge at Rigolets Pass, a maximum slump of 2 in. was maintained throughout. Sieve analyses and colorimetric tests were made of the aggregates received. After a few rejections on account of improper grading and uncleanness, these deficiencies, in the aggregates were corrected. No test cylinders were made but the concrete is very hard and firm.

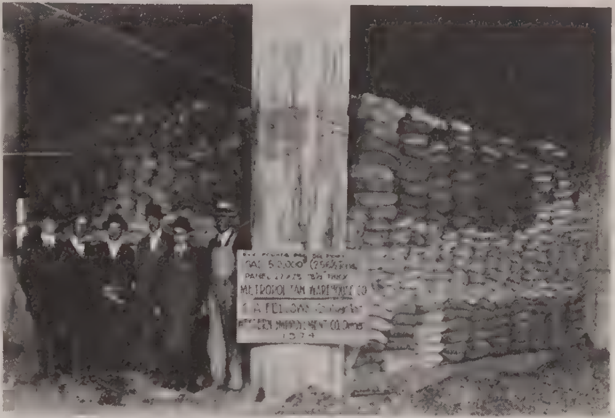
The Northern Pacific R. R. Co. has taken definite steps to standardize methods of making concrete.

One test specimen is made for a fixed number of cubic yards of concrete. This railroad is making a study of the possibility of adopting standard detailed rules for the application of field control methods.

The New York Central has established a laboratory at Cleveland for training resident and assistant engineers to use scientific methods of control on all future concrete work.

Other railroads contemplating the adoption of scientific methods of field control are the A. T. & S. Fe Ry., the C. B. & Q. Ry. and C. M. & St. P. Ry.

Severe Test of Warehouse Floor



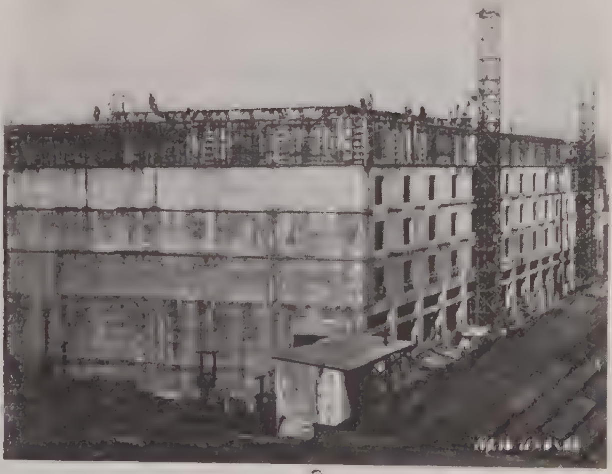


Fig. 1—The floor panel with test load in place

Fig. 2—General view of warehouse under construction

Standing up under a load of 513,000 lbs. or 6 carloads of cement loaded upon a floor space approximately 20 ft. square, the new building being erected for the Metropolitan Warehouse Co. at Sixth and Mill streets, Los Angeles, has set a new mark for the carrying capacity of floors in that city, according to E. B. Conants, inspector for the Los Angeles city building department. This test is the most severe that has been applied to any floor by the building department of that city. The building is being erected by the C. A. Fellows Co.

At the request of the city building department, the entire load was left on this space for 18 hours during which time the maximum deflection of the floor was but $\frac{9}{32}$ in. The deflection was recorded by a device placed directly underneath the center of the area tested. As the building department has never before ordered such a severe test to be made, this remarkable performance no doubt will be regarded as a precedent as to what the department will expect in making tests of future industrial structures.

Some idea may be gained as to the magnitude of this building, from the statement that it will contain approximately seven acres of floor space, according to A. Meyers, vice president of the Metropolitan Warehouse Co., and it will be supported by 102 footings, each 18 ft. square and containing approximately 1300 cu. ft. of concrete.

The building will be served by double track spur of the Atchison, Topeka & Santa Fe Ry., and will enable the warehouse company to have 18 freight cars placed at the warehouse for loading or unloading at one time.

The Metropolitan Warehouse Co. is engaged in the storing and distributing of merchandise for its eastern and foreign clients and will operate in conjunction with the California Truck Co., one of the oldest firms in the draying and distribution business of Los Angeles, having incorporated in the year 1884. This company in keeping pace with the rapid development of Los Angeles has found it necessary to have a modern warehouse building erected and therefore organized the Metropolitan Warehouse Co. This huge structure, along with other warehouse buildings which are completed and those now under construction, will take care of the storage needs of this territory for some time to come.

The building was started on June 1, 1924, and will be completed in January, 1925, at which time the general offices and the executive offices of the California Truck Co., as well as of the Metropolitan Warehouse Co., will be located at the new building, occupying the entire Sixth Street frontage of the ground floor.

The executives of the Metropolitan Warehouse Company are H. B. Safford, president, A. Meyers, vice president, Rowe Sanderson, secretary and treasurer.

Safeguarding Brick Sewers

Old Brick Sewers Reinforced by Concrete Lining While in Service

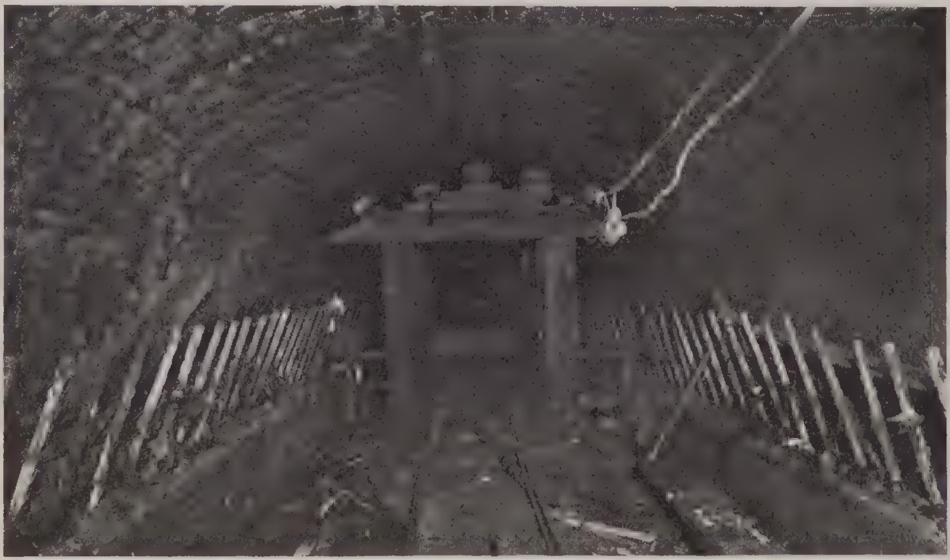


Fig. 1—Greene Ave. sewer looking west in Greene Ave. Side walls concreted ready for arch. Temporary floor, service track and roof shoring in place

Sections of about 2500 ft. of the 3-ring circular brick sewer in Greene Ave. and about 2150 ft. of egg shaped sewer in Lewis Ave., Brooklyn, which had settled and cracked so as to be considered unsafe, are being reinforced with concrete while still in service for storm water flow. The construction of concrete linings strong enough to carry the maximum possible roof loads and to virtually provide new sewers at a third of the cost of building independent sewers or replacing the present ones on the same lines is progressing rapidly. Nearly all of the old brick work is left intact serving as exterior forms, obviating the necessity of trenching, tunneling, or other excavation and at the same time maintaining uninterrupted flow of storm water while construction is in progress. The old brick sewer in Greene Ave. was 10 ft. in diameter and the egg shaped section in Lewis Ave. was 54 in. x 69 in.

A plank floor nearly 8 ft. wide was built over the invert in the Greene Ave. sewer and on it a 24-in. industrial track was laid. One-half yard cars installed on the track were used to remove portions of the old brick work cut out of the inner surface between the spring line and the invert to make room for the side walls of the lining, and also serve to deliver concrete. The concrete for the lining is mixed 1:2:4 with Atlas portland cement and ¾-in. gravel. It is dropped through an 8-in. pipe from the street above at a working shaft about 30 ft. deep. The shaft is served by a derrick operated by a Lidgerwood hoisting engine. From the foot of the shaft the lining was started simultaneously in both directions, progressing at the rate of about 14 ft. per day at each end.

As fast as the floor platform was set, two rows of vertical shores were set on it to support the roof arch, and triangular sections of brickwork were cut out on both sides to a depth of about 30 in. below the axis of the sewer. Vertical wooden form panels were set for the inner faces of the side walls, inclined reinforcement bars, 4 ft. long placed in them 8 in. apart longitudinally and the forms filled with concrete shoveled in by hand.

On the concrete side walls in each heading, a 14-ft. rigid section of wooden arch centers and lagging was placed, enclosing horizontal longitudinal and curved transverse reinforcement bars wired to the projecting ends of the side wall bars. With the progress of the work, the forward end of the form is bulkheaded nearly to the top with boards, leaving a small opening at the crown through which concrete is delivered by a 6-in. discharge hose from a horizontal concrete gun[3], located 25 or 30 ft. away. This concrete gun occupies a space only 28 in. wide, 38 in. high and 99 in. long over all, on one side of the floor platform and is easily advanced as the

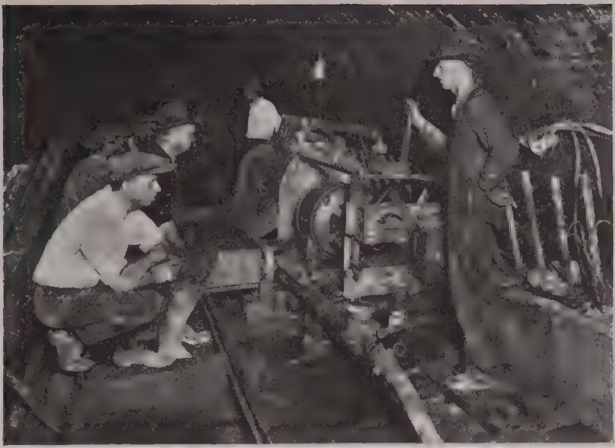


Fig. 2—Concrete gun placing arch lining in Greene Ave. sewer tunnel

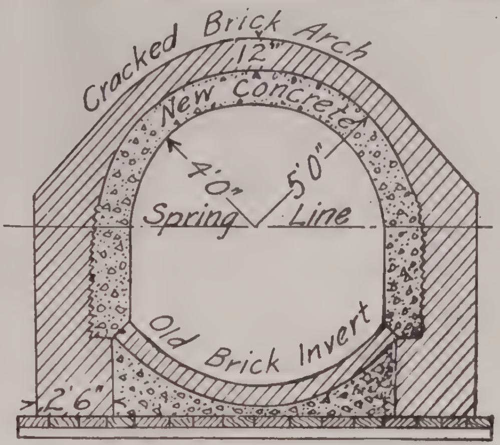


Fig. 4—Cross section showing Greene Ave. sewer repaired

work progresses saving time and labor and leaving plenty of working space to pass by as well as for the cars to operate on the service track.

The work progresses steadily at the rate of 28 linear feet of completed lining in one 8-hour shift. Eventually another construction shaft will be opened up and to it will be transferred the mixing plant, compressor plant, concrete mixer, and derrick equipped with 2-drum Lidgerwood hoisting engines installed in the street at the heat of the first shaft. The work will require about 3000 cu. yds. of concrete for the Greene Ave. tunnel and about 1100 cu. yds. for the Lewis Ave. section. The total force employed is about 50 men for the large sewer and 20 for the small sewer, including those at the mixers on the surface. The concrete is dense and solid with a good smooth surface and uniform finish making a very satisfactory job.

The Ransome type pneumatic concrete placing machine used has a horizontal barrel 2 ft. in diameter and 4 ft. long, in the lower part of which, parallel to its axis, there is a helicoidal conveyor 12 in. in diameter with its shaft passing through a bushing in the rear end of the barrel. The shaft is geared to a 7½ h. p. electric motor mounted on the frame of the machine. As the small diameter of the tunnel did not permit the concrete to be dumped from the car into the barrel of the machine, it was shoveled into a circular hole in the upper side of the barrel closed with a gasketed door opening downward and held firmly in position by the air pressure.

When the placing machine is in use, the concrete is deposited in 7-cu. ft. batches directly over the conveyor screw that moves it forward toward the outlet and keeps the space under the door clear. The air pressure is admitted to the barrel beyond and not above the concrete, and after first passing freely through the outlet in the unobstructed well in the bottom of the barrel at the forward end, it escapes through a 6-in. discharge hose, drawing the concrete through the hose and chuting it violently into the form.

Most of the batch is discharged in 10 seconds by the action of the air alone after which the screw is started which pushes the remainder toward the outlet, through which it is forced by the air, completing the operation in a total of about 15 seconds. The machine is operated by an electrically driven portable compressor on the surface of the ground, with a capacity of 300 cu. ft. of free air per minute, which has proved ample. To do the same work under the same conditions, the old gravity type pneumatic mixer required a compressor rated at at least 750 cu. ft. per min. This excess of air was necessary

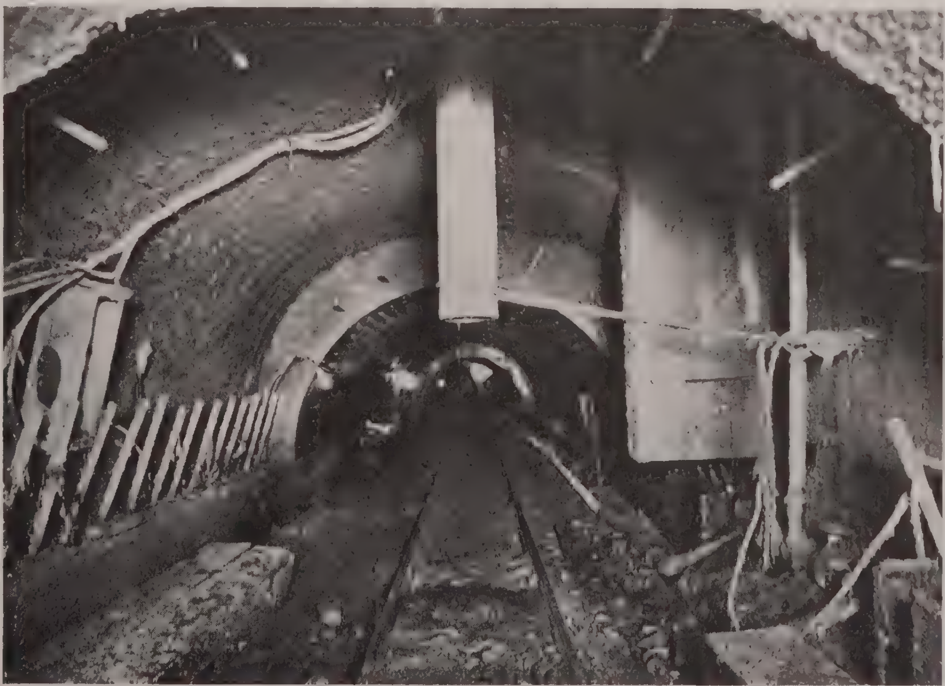


Fig. 3—Looking east at manhole in Greene Ave. sewer. A vertical 8-in. pipe delivers concrete to dump cars on service track on the invert platform. Completed arch and wall concreting are also shown

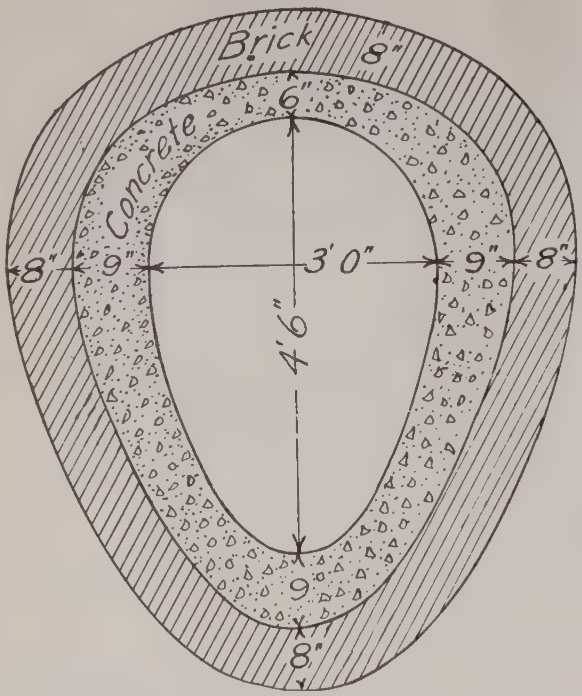


Fig. 5—Cross section showing Lewis Ave. sewer with concrete lining in place

to develop and maintain pressure in the entire volume of the tank and discharge line during the whole of the time required to complete the placing of the concrete and to compensate for heavy leakage through the mass of concrete which was deposited directly over the outlet of the tank. In test operations, the machine shot concrete 20 ft. when operated by a portable compressor of 200 cu. ft. capacity.

In use, the discharge end of the hose is inserted through the top of the arch form bulkhead to whithin about 5 ft. of concrete already placed, against which the fresh concrete is shot. The concrete falls by gravity on both sides until, as the hose is withdrawn, the form is filled up nearly to the crown. The key concrete is then shot in by the machine, packed in very densely, filling the form completely except for about 6 or 7 cu. ft. of open space left by the withdrawal of the nozzle, well above the intrados of the arch. This does not affect the arch soffit and the space is immediately filled when concreting of the next section is commenced. This method really provides a desirable bond between sections.

In tests of cubes of concrete placed in New York subway arches by the pneumatic placing method, the concrete developed a strength per sq. in. greater than that of cubes of similar concrete placed by hand.

Each 14-ft. section of the Greene Ave. sewer lining requires from 15 to 18 cu. yds., deposited in about 3 hours by from 60 to 72 shots from the machine. This efficiency, it is believed, effects a saving of about 30% in labor and 50% in time over hand placing.

All the concreting is done by one gang. The program calls for concreting a 14-ft. section of side walls first and then returning each day two or three sections back and concreting a corresponding arch section. The arch centers are supported on pairs of wedges on longitudinal sills. The wedges are slacked off, lowering the centers to bearing on rollers over which the centers are easily advanced 14 ft. to the next position where the rear end of the form overlapps 6 in. on the finished concrete. The rigid arch center is adjusted by pairs of wedges and by braces against the service track to prevent possibility of transverse displacement.

The Lewis Ave. storm sewer which discharges into the Greene Ave. sewer is being completely lined, arch, side and invert, with a minimum thickness of 6 in. of unreinforced 1:2:4 concrete made with Atlas portland cement and ¾-in. gravel, requiring about ½ cu. yd. per lin. ft. This concrete is mixed in machines in the street and dropped through two 8-in. pipes to ½-yd. cars operated on a 24-in. gage service track laid on cross ties wedged against the sloping sides of the brickwork.

The space inside the sewer does not afford clearance for even so small a machine as the concrete gun, therefore the concrete is shoveled by hand into the special adjustable steel forms made in two pieces, one for the invert, extending up to the height of greatest width of the sewer and the other for the arch. Both forms are stiffened with curved transverse angle ribs and with longitudinals. Small horizontal channels stiffen the longitudinal joints lines which are securely bolted when the arch form is set on the invert form. Horizontal transverse turnbuckle tierods collapse the forms sufficiently to permit their withdrawal from the concrete surface.

This lining requires about ½ cu. yd. of concrete per linear foot and is placed at the rate of 14 ft. in each 8-hr. shift by each of two gangs. The sewer is dry except during and immediately after rains when the flow passes through the forms without damage to them.

A longitudinal opening about 12 in. wide is left in the sheet steel covering of the arch centers for placing the concrete, and is closed by short thin plates when the key is rammed in. Short special forms are used to connect the steel forms to

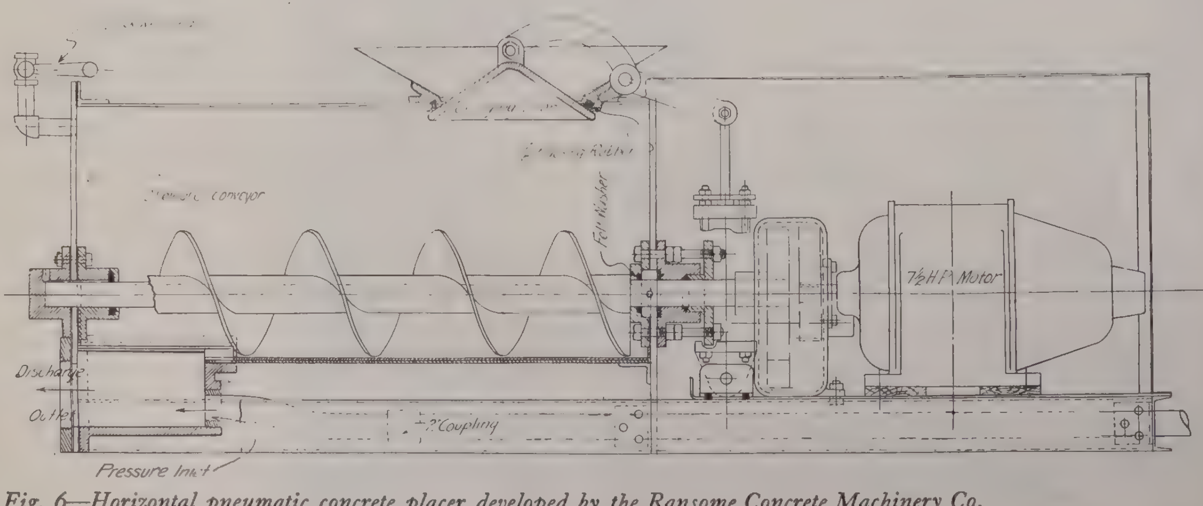


Fig. 6—Horizontal pneumatic concrete placer developed by the Ransome Concrete Machinery Co.

the inner surface of branches emptying into the Lewis Ave. sewer.

The rapidity and economy of this method of placing concrete in the forms is even greater where there is sufficient clearance to permit dumping the concrete directly into the barrel of the placing machine, which may then be filled in 5 seconds and operated with maximum rapidity. If care is taken to keep it's gasketed bearings clean so that the charging door closes perfectly, there are no plugs or interruptions in the discharge such as may be caused by leakage of air pressure in the barrel.

The work on both sewers is being executed by Booth & Flinn, New York, in accordance with the plans and specifications of the Bureau of Sewers Borough of Brooklyn, A. J. Griffin, chief engineer. The concrete placing machine was installed by John P. Fitzgerald.

Guncrete Restores Damaged Building

The use of Guncrete in repairing a reinforced concrete warehouse in Evansville, Ind., which was damaged seriously by the burning of the building's contents, resulted in the restoration of the building to its original designed strength. In August 1924, the Sterling Products Co. of Evansville had a disastrous fire in its warehouse. The building, a four-story concrete structure of the flat slab type with brick exterior walls, was originally built for a bottling plant and there were holes through all the floors where conveyors, package chutes, and bottling machines passed from one story to another. These holes were unprotected by fire stops and the fire quickly passed to all parts of the two upper stories. For the most part these two stories were filled with crated furniture and by the time firemen reached the blaze the fire had gained such headway that it was impossible to stop it, and it was therefore allowed to burn itself out.

The damage to the building can be readily seen by the accompanying illustrations. Fig. 1 gives a view of a portion of the top floor showing how columns were spalled to the reinforcing, and column capitals and drop plates badly disintegrated. Large cracks are also shown in the roof slab. These cracks invariably followed the construction joints or bulkheads used when pouring the slab. Fig. 2 is a view of the underside of the third floor slab. This is one of the places where a test load was applied after the Guncrete repair work was completed.

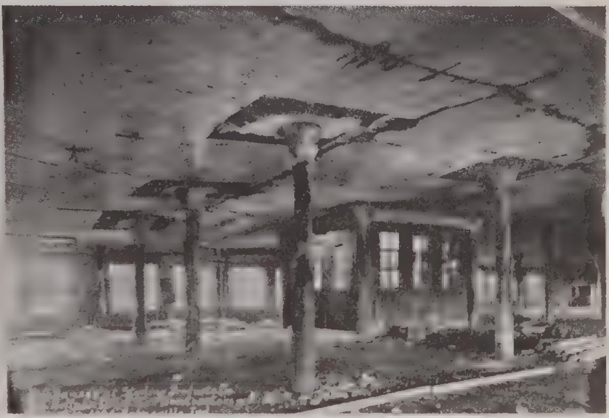
In order to repair the columns it was necessary to first remove all loose and disintegrated concrete. In most cases this meant taking off everything outside of the spiral reinforcing. In no case was this less than 2 in. This was done with pneumatic chipping hammers. Guncrete was then shot against these columns, building them up to their original dimensions. The column capitals and drop plates were also cleaned off and built up in this way to their original dimensions.

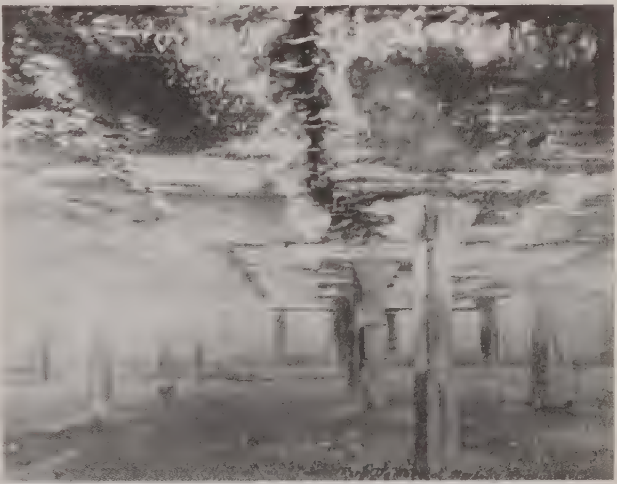
In repairing the floor slabs all loose and disintegrated concrete was first removed and the entire underside of the slab cleaned by sand and water-blast. In many places, particularly along construction joints, this necessitated cutting the slabs clear through, thus exposing the reinforcing bare for a width of from 3 to 15 in. Guncrete was then shot in place, replacing all the defective concrete that had been removed and coating the underside of the slab, restoring all surfaces to their original lines.

Fig. 3 shows a portion of the underside of the third-floor slab after restoration. The light colored streaks on the ceiling are where the slab was cut clear through when removing disintegrated concrete and where the original concrete was replaced by Guncrete.

Fig. 4 shows a portion of the top story where there was little to burn. Directly under this floor, however, the fire was very hot and the result can be seen from the buckling of the top or finished coat on the floor of the panel shown. This is one of the places where the slab was cut clear through, leaving the reinforcing bars exposed.

In order to determine the advisability of repairing the building with Guncrete, one of the worst panels was repaired by this method and after allowing it to set for 25 days it was subjected to a test load. The results of this test showed the





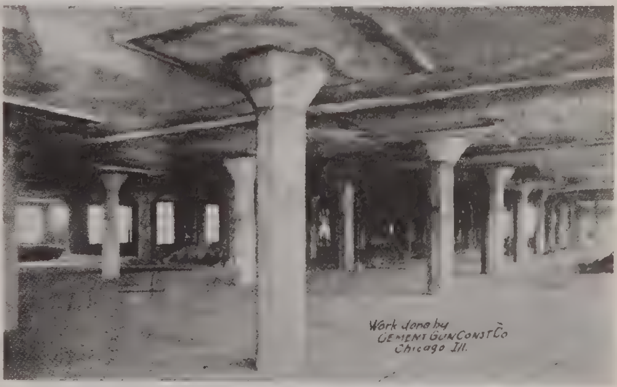


Fig. 1—Portion of top floor after fire showing badly spalled columns and column capitals and cracked roof slab

Fig. 2—Underside of third floor

Fig. 3—Underside of third floor after restoration

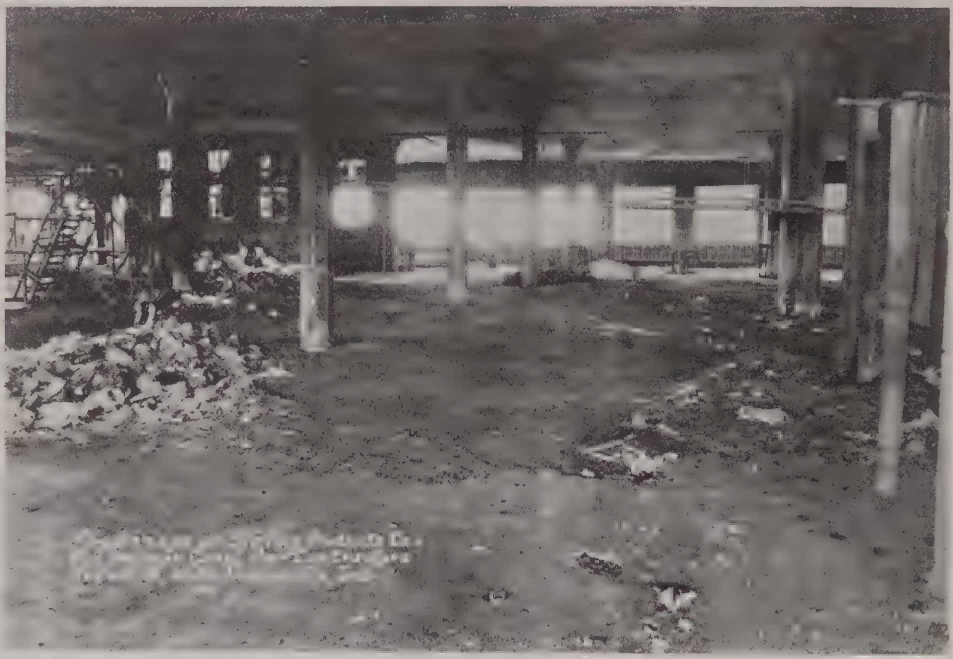
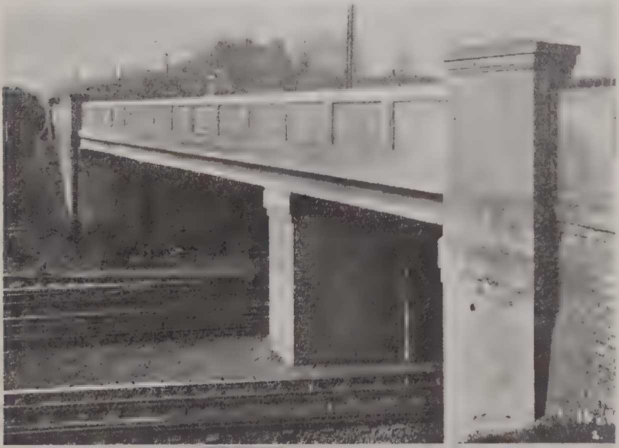


Fig. 4—View of top story showing how the finish coat on the floor buckled because of intense heat of fire on floor below

panel to be fully restored to its original designed strength. As a result of this test it was decided to repair the rest of the damaged columns and floor slabs by this method.

The M. J. Hoffman Construction Co., Evansville, Ind., were the general contractors for this work, the Guncrete work being done by the Cement-Gun Construction Co., Chicago, specialists in this kind of construction, and to whom we are indebted for the above information and photographs.



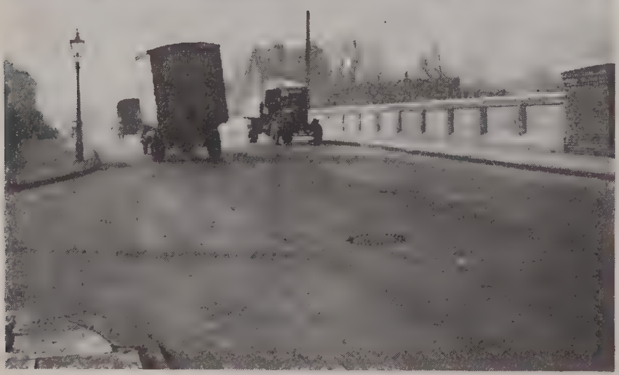


Fig. 1—Chiswick Ry. bridge—the first bridge in Great Britain to be constructed of impervious concrete

Fig. 2—Road surface of Chiswick bridge

Concrete Bridges Increasing in Britain

Undoubtedly the weakest part of the road system of Great Britain, having regard to the heavy loads imposed by the increase in mechanically-propelled vehicles, lies in the numerous bridges over rivers, canals, and railways. Consequently, in the program of road construction now being undertaken, a very considerable amount of new bridge work has been necessary. For this purpose concrete is being used to a great extent, and numerous interesting examples of concrete bridges are now under way. The cost in the majority of cases will be less than that of steel construction, and maintenance charges will be lower.

One of the latest contracts to be let is for a bridge over the River Tweed at Berwick, Scotland, where for road traffic there is at present only an old narrow bridge 920 ft. long. It is an interesting fact in connection with the Tweed bridge that a Royal grant for maintenance was given in the reign of King Charles II. The other existing bridge over the Tweed, the famous Royal Border Bridge, carries the main line of the London & North-Eastern Ry. to Scotland. This structure is nearly half a mile long and is 136 ft. above the river. It was designed by Robert Stephenson and has been in service for 75 years.

The new bridge, work in connection with which has just been commenced, has been designed as a concrete and reinforced concrete structure, 1,405 ft. long and 46 ft. wide, which will give a roadway of 30 ft. and two footways each of 8 ft. There will be five main piers constructed of mass concrete, but the superstructure will consist of 4 arch and 2 approach spans of reinforced concrete. The bridge is remarkable for the size of the arch spans. That on the Berwick side of the river will be 361 ft. 6 in.—the largest reinforced concrete bridge span in Great Britain. The contract price is £160,000 (normally $800,000), and the work is expected to occupy 2½ years.

The arch spans will be constructed with four arched ribs hollow from their springing point for a third of the length, and from the arch spans vertical supports will be carried up to decking level. The vertical columns which will connect the ribs with the decking will vary in size, but the general design of decking is that of a reinforced concrete slab 8 in. thick, having transverse beams 7 in. wide and 20 in. deep and longitudinal beams connecting the uprights 10 in. wide by 30 in. in depth.

Another cross-river bridge is being erected at Reading, to replace an old steel structure which had become unsuitable for modern traffic. As the new bridge is being built on the site of the old one, and facilities for cross-river traffic in the meantime were regarded as essential, it was decided before demolishing the old bridge, to build a new structure over the river a little farther down stream. When this was completed last October, the removal of the old Caversham road bridge was started and work is now in progress on the foundations of its successor. The bridge has been designed in the form of 2 arches, one of 126 ft. 4½ in., and the other of 106 ft. 4½ in. span, and it has been necessary, in order to obtain an easy gradient on the Caversham side, to make one of the arch spans exceptionally flat. A wide bridge is being provided with two central promenade bays around the central pier. The width of the bridge is 56 ft., which will be divided into a roadway of 32 ft. and two sidewalks of 12 ft. each. The center pier is being constructed on an island in the river, where the builders have uncovered the foundations of a very old masonry bridge, which appears to have been constructed by the monks connected with Reading Abbey. Beside the bridge foundations were unearthed the remains of an old 14th century chapel, the masonry of which was in such good preservation that it has been removed and will be used in some form by the Reading Corporation. It is clear that when the chapel was built the river level must have been much lower than it is now.

Grants ranging up to 75% of the costs are being made towards these and a number of other concrete bridges by the Ministry of Transport, and all the bridges are being designed in accordance with the standard loading regulations of the Ministry.

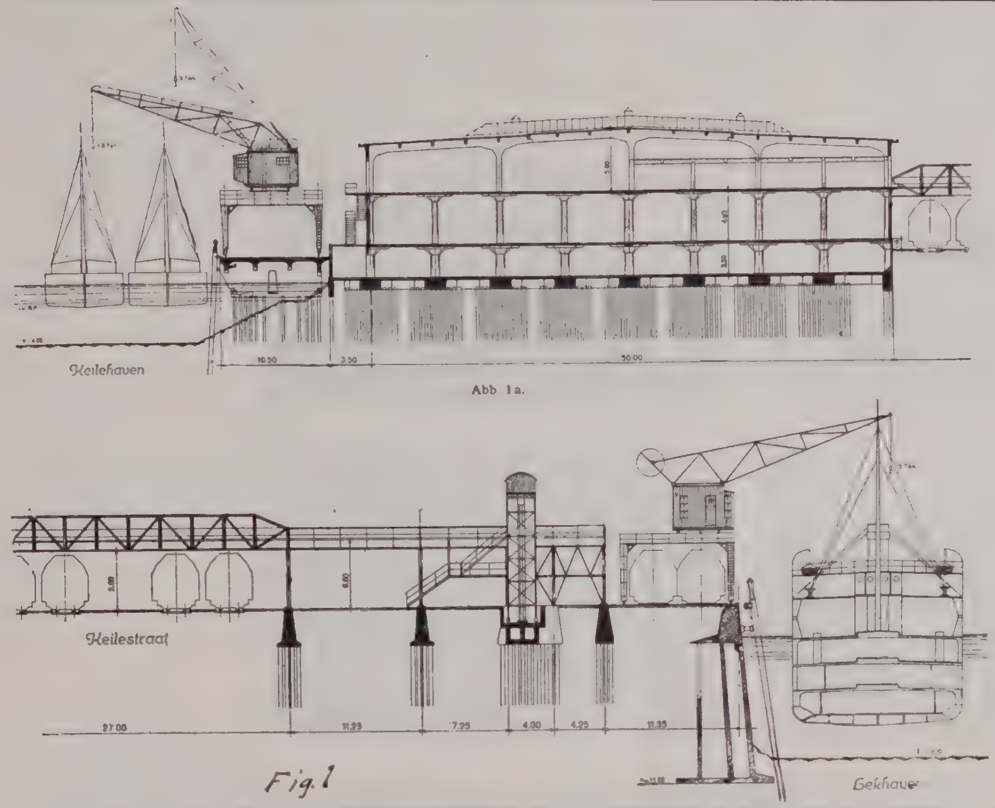


Fig. 1

Fig. 1 — Sectional elevations showing warehouse, train shed and canal

Remarkable Warehouse Construction on Made Ground

From *Der Bauingenieur,* extract by E. Lee Heidenreich

The description of the Thomsen Warehouse in Rotterdam, Holland, in *Der Bauingenieur,* is very interesting in that the foundations described are based on made ground, and the entire construction is of reinforced concrete, mostly flat slab, exceptionally neat and clean.

Fig. 1 shows a cross section of the warehouse with canal and train shed, as well as the support for the traveling gantry crane for loading and unloading vessels and canal boats.

Fig. 2 is a view of the interior, in which the corners of the crop caps are shown cut off, and the corners of the columns chamfered from about 3 ft. from the floor up, an altogether pleasing effect.

The reinforcing design provides for a regular two-way structure, with every rod hooked, which is not an American habit, but wonderfully effective.

The live load on the floors is figured at 425 lb. per sq. ft., and the dead load weight of the 10-in. floors at 130 lb. per sq. ft.

The spans are 19 ft. x 20 ft. and the dimensions prove to be somewhat lighter than the Chicago Building Code prescriptions between columns, and heavier than these over column heads and in panel centers.

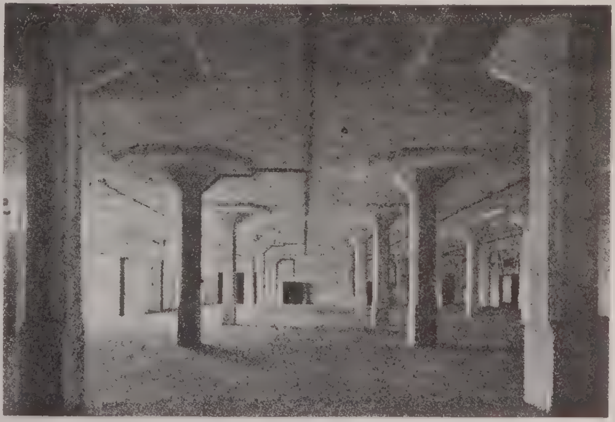


Fig. 2—Interior view showing type of construction

Cantilever Bridge of Concrete

In connection with the improvement of the Newark-Mt. Vernon intercounty highway in Ohio, two reinforced concrete bridges of an interesting design have been built. One is over the Clear Fork and the other over the Lake Fork, in Licking County. Both bridges are of the reinforced concrete cantilever type of 54-ft. span, the only difference in them being in the height of their piers.

The bridges were designed to carry a 15-ton truck. The floor beams carry the floor and load and transfer it to the girders at the floor beam points as concentrated loads. Influence lines were used to determine loadings for maximum stresses.

To avoid the use of construction joints in the main structure the floor and two main girders of each bridge were poured in one operation. The approach slabs at each end of the structures were poured later. The top of the floor beam at each end of the cantilever was provided with a half-round groove 4 in. deep, for the entire width of the roadway, to support the approach slab. This groove was painted with a coat of bituminous material before the slab was poured. The outer end of the slab was provided with a shallow foundation 3 ft. deep and 1½ ft. thick. No heavy abutments were required.

The Newark Paving & Construction Co. did the work under the direction of Paul M. Henry, bridge engineer, Ohio State Highway Department, Newark, Ohio.

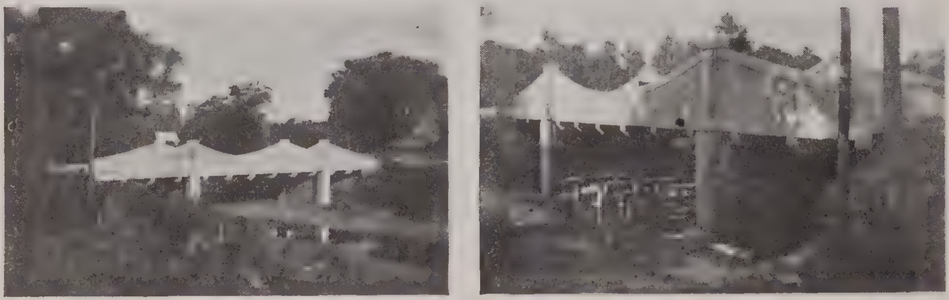


Fig. 1-2 (Top)—Brush Fork and Lake Fork cantilever bridges

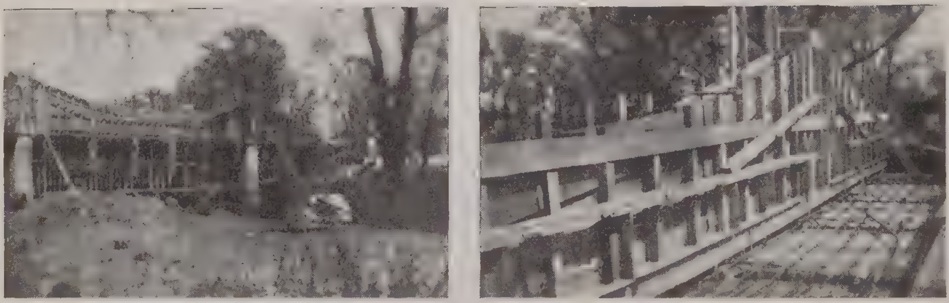


Fig. 3-4—Form work in place for superstructure, Lake Fork bridge

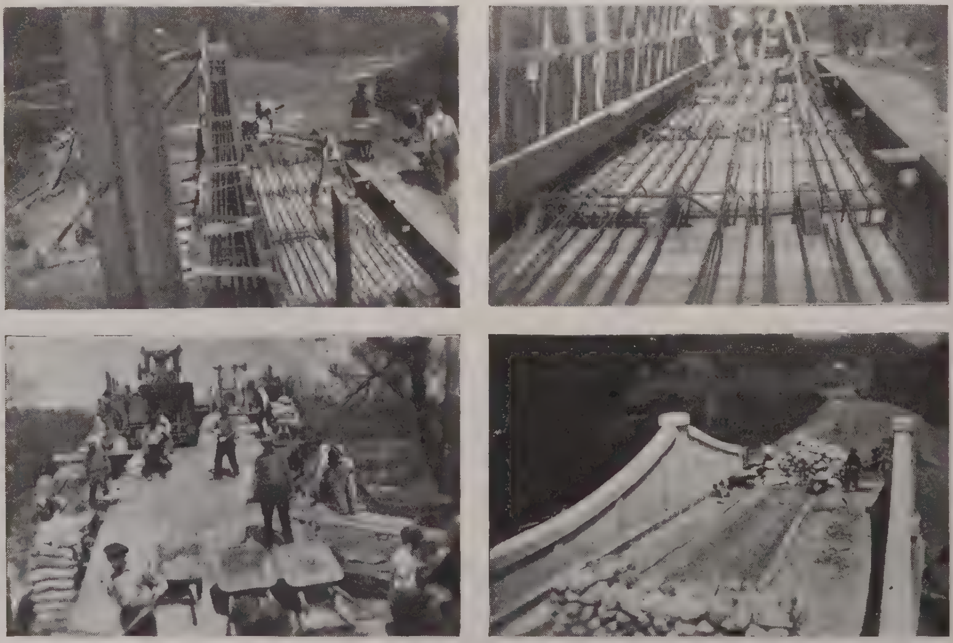


Fig. 5-8—Construction views showing reinforcement and final testing of Lake Fork bridge

Plaster for Shower Bath Walls

A plaster made of portland cement and sand with about 10 lbs. of hydrated lime per bag of cement can be used satisfactorily for plastering walls of a shower bath. With each bag of cement should be mixed 2 cu. ft. of plastering sand, that is, sand which is well graded from ⅛-in. maximum size to fine particles.

This plaster must be applied to metal lath and not to wood lath. When wood lath is used, it is bound to absorb more or less moisture from the bath or from the moist atmosphere, which causes the lath to swell and eventually disturb the plaster, thereby developing objectionable cracks. If possible, the construction should be arranged so that the metal lath can be back-plastered, that is, plaster should be applied to both sides of the lath. If this is impossible, however, a very satisfactory job can be obtained if the lath is applied over heavy building paper, so that when the mortar is pressed through the meshes of the wire lath it will be pressed against the paper so as to completely embed the lath in the mortar and protect it from rusting. A good grade of galvanized wire lath is probably better for this work than expanded metal, although expanded metal will be perfectly satisfactory, provided it has been enameled or painted after the metal is cut.

At least three coats of plaster must be used, each being from ¼ in. to ⅜-in. thick. If a smooth finish is desired, it will be necessary that the plasterer allow the last coat to become partially hardened before he gives it the final finish with a steel trowel. This will ordinarily require from 20 to 30 minutes after it is first applied.

Portland cement plaster can be painted like any other masonry surface. Before applying oil paints, of any kind however, it should be given two brush coats of a zinc sulfate solution made by dissolving one pound of zinc sulfate crystals in a gallon of water. The zinc sulfate neutralizes any free lime which might be present in the mortar in an active state, so that it would attack the oil in the paint if not properly neutralized before the paint is applied. Excellent enamels for this kind of work are manufactured by the Boston Varnish Co. and by the Pratt & Lambert Varnish Co. The Pratt & Lambert product is sold under the trade name of Vitrolite, while the Boston Varnish Co.'s product is known as Kyanize Enamel. Two or three coats of either of these enamels will produce a surface which is almost equivalent to a glazed tile surface and can be obtained at a small fraction of the cost of a tile surface. No waterproofing material of any kind is recommended or required for this work.

Concrete Test Road in Pennsylvania

From *Public Roads*, Published by the U. S. Bureau of Public Roads.

The Pennsylvania State Highway Department and the United States Bureau of Public Roads are cooperating in the construction of a concrete test road located on State Route No. 50 in the vicinity of Harrisburg, Pa. The project selected is approximately 1700 ft. long, and its site is on a silty loam soil through swampy land.

The purposes of the test road are as follows:

1. To determine the action of a concrete pavement with a 5-in. center thickness and 8-in. edge thickness (8–5–8 section) under a 26,000-lb. gross load.
2. To determine the influence of subgrade material on the strength of the pavement.
3. To obtain further data on balancing the cross-section design.
4. To determine the effectiveness of the tongue-and-groove type of longitudinal joint.

Six different types of subgrades have been prepared. They are as follows: old macadam road scarified and rerolled, sandy loam, shale, clay, clay overlaid with 4 in. of sand-clay mixture, and clay overlaid with 4 in. of cinder-clay mixture.

Concrete construction is being carried out in the usual manner, and at approximately the center of each subgrade section a transverse expansion joint is being provided. Adjacent to this expansion joint and on one side of the longitudinal joint over a length of 20 ft., inserts are being placed in the slab in such a manner that strain gauge readings may subsequently be obtained both for the top and bottom of the slab.

Control specimens, consisting of beams and cylinders, representative of the particular portion of the pavement in which the strain gauges are to be installed are being made. These specimens are to be tested and broken at the ages of 15 days, 28 days, 6 months and 1 year, for the determination of the modulus of elasticity, the modulus of rupture, and the compressive strength of the concrete.

The pavement when completed will be subjected to heavy truck loads up to 26,000 lb. gross. Stress readings will be obtained with the truck run near the edge and at the center of the road. The truck will be run during the summer and during the time of the spring thaw. Field determinations of subgrade moisture and bearing value of the soil will be made on the day stress readings are obtained.

From the results of the above tests it is hoped that answers will be supplied to the following questions:

1. Is an 8–5–8 section adequate for occasional 26,000-lb. traffic?
2. What influence has the subgrade on the strength of the slab?
3. Will a 4-in. layer of good material improve the strength of a concrete road when laid on a poor subgrade material?
4. Is an 8–5–8 section a balanced design, or should the center and edge thickness be adjusted?
5. How much of the load does the tongue-and-groove type of longitudinal joint transmit from one side of the slab to the other?
6. If an 8–5–8 section is not safe under a 26,000-lb. load, what is the safe load under spring conditions and under ordinary conditions?

Static Load Tests on Pavement Slabs

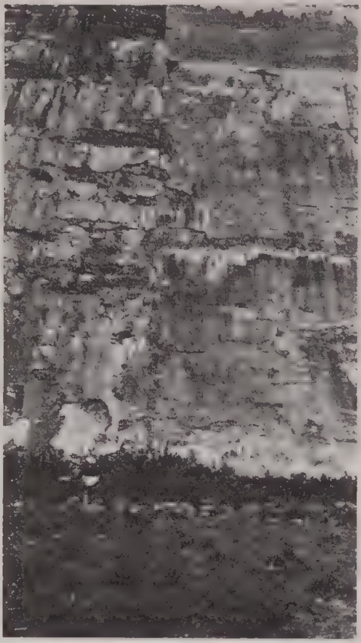
By J. T. Thompson
Highway Research Specialist, United States Bureau of Public Roads

Four years ago the Bureau of Public Roads began the testing of approximately 50 small typical road slabs under impact forces. The success of this early program led in the summer of 1921 to the construction of 124 larger slabs embracing a greater variation of type. These slabs were tested under impact during the summer of 1923 and the results of the test were fully reported in the article entitled "Impact Tests On Concrete Pavement Slabs," published in *Public Roads*, vol. 5, No. 2, April, 1924.

After these impact tests were concluded it was thought that a check on the impact results and additional information could be obtained by subjecting the slabs to tests under loads applied statically instead of dynamically. It is with these static tests, conducted during the summer of 1924, that a new report in *Public Roads* concerns itself.

A summary of conclusions follows:

1. The static resistance of both the corners and the edges of the rigid slabs is affected by the nature of the subgrade, the more resistant the subgrade to load the greater the resistance of the slab, and vice versa.
2. The resistance of the rigid slabs to static loads does not vary with the square of the depth but as some power greater than one and less than two. About 1.75 is the average value, the exponent being higher for slabs on the wet subgrade and lower for those on the dry subgrade.
3. The corners and edges of concrete slabs of the size and



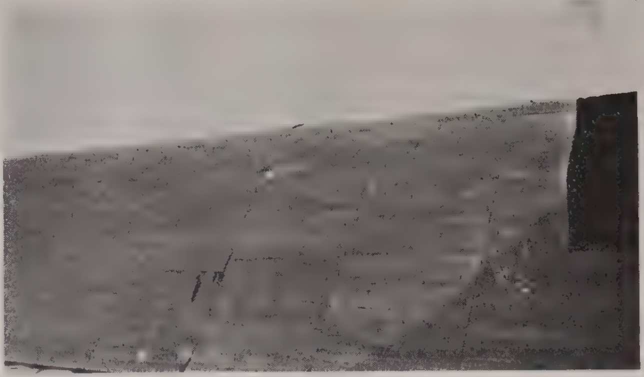
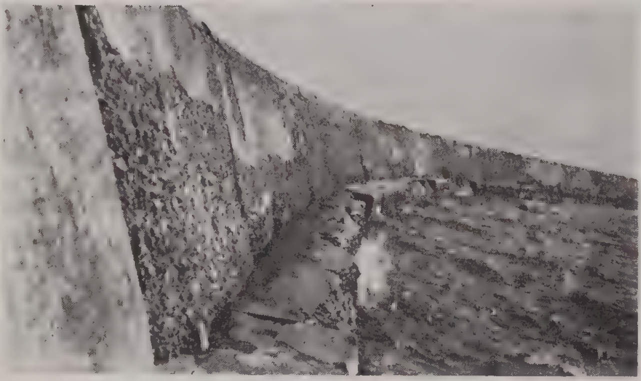
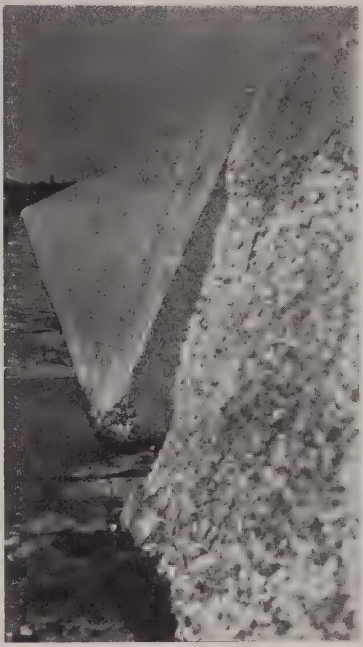


Fig. 1—At left
Fig. 2—Above
Fig. 3—Below
Fig. 4—At right





thickness tested offer about the same degree of resistance to static loads.

4. The presence of mesh reinforcement as employed in the slabs under consideration does not increase the load-carrying capacity of concrete slabs but does give rise to a tendency to hold together and resist complete failure after initial or elastic failure has taken place.

5. The bituminous topping laid on the rigid slabs does not increase the resistance of the slabs to static load.

6. At the ordinary summer temperatures encountered, bituminous slabs of the types tested show no slab strength.

Destructive Action on Porous Concrete

There is nothing so good for an industry as to face its mistakes and its shortcomings honestly and courageously. The American Concrete Institute is doing this as told in a recent *News Letter*.

Committee E-6, Destructive Agents and Protective Treatments, M. M. Upson, chairman, has one of the most disagreeable and one of the most important of committee assignments—the job of prying into the *hows* and *whys* of poor concrete. A foretaste of a report that promises a great deal of interest and importance is found in the accompanying pictures from the committee's files:

Figs. 1 and 2 show the destructive action of percolating water on porous concrete. Fig. 1 shows a portion of a dam badly affected by percolating water and frost; concrete 1:2½:5 mix placed in extremely wet condition resulting in porous concrete. Fig. 2 shows a portion of a dam of about the same age and exposure as the one illustrated in picture 1 only slightly affected by percolating water. Concrete 1:2½:5 mix placed in plastic condition without excess of water.

Figs. 3 and 4 illustrate the destructive action of waves and frost on porous concrete. Fig. 3 shows a breakwater built in 1906 with 1:3:5 concrete, badly affected. The left foreground shows the portion illustrated in Fig. 4, which in turn shows a portion of the same breakwater built in 1904 with 1:2:4 concrete still in excellent condition. The foreground shows end of the 1:3:5 section illustrated in Fig. 3.

The index to CONCRETE Vol. 25, July to December, 1924, will be sent to all subscribers who ask for it.

Courtesy the Portland Cement Association

Contractors Take Pride in Their Work

Contractors, as well as builders of many fine articles, take pride in work well done. When the Thoney Pietro Construction Co., Morgantown, W. Va., recently completed the construction of a 7-mi. link of the Northwestern Pike between Ellenboro and Pennsboro, it received many congratulations on the splendid piece of concrete work it had done.

Thoney Pietro, with a feeling of pride, decided to leave some practical monument that future generations might know who had laid the roadway over which they were traveling.

During the course of the work, a fine, clear spring had been uncovered along the road. This was enclosed in concrete and sealed against the solid rock, so that there would be no chance for contamination. A basin in front catches the water as it drips down. The overflow is carried by pipe to a horse trough some 60 ft. down the road.

The spring is curtained off by a wall of concrete which bears the inscription, "Compliments of the Thoney Pietro Construction Co."

Impact Tests on Highway Bridges

A progress report of cooperative research conducted at Ames, Ia., as given in *Public Roads*, a journal of highway research, published by the United States Department of Agriculture, gives some interesting information regarding impact stresses in highway bridges subjected to motor truck loads, tested recently as a continuation of the work begun in 1922. The cooperating agencies are the Iowa State Highway Commission, the Engineering Experiment Station of Iowa State College, and the United States Bureau of Public Roads.

The greater part of the work in 1923 was done on the 8-panel 150-ft. main span and the 32-ft. approach span over the Skunk river on the Lincoln Highway near Ames, Ia. A few days' work was done on each of two other structures, one a 70-ft. through plate girder bridge with an 8-in. concrete floor supported on steel stringers, located on the Lincoln Highway over Squaw creek in the city of Ames. The other was a 5-panel 40-ft. riveted steel pony truss bridge with 8-in. reinforced concrete slab resting directly on floor beams, located near Roland, Ia. The work included observations of static load and impact stresses on all the bridges. Three conditions of impact were observed—one with the trucks operated over the clean bridge floor, one in which the trucks were driven over a 1 x 2-in. obstruction and one in which they were driven over a 2 x 4-in. obstruction.

Probable percentages to be added to static load stresses to allow for impact are given as follows:

For stringers: Clean floor, 12%; 1-in. obstruction, 40%; 2-in. obstruction, 80%.

For floor beams: Clean floor, 10%; 1-in. obstruction, 40%; 2-in. obstruction, 57%.

For hip verticals: Clean floor, 25%; 1-in. obstruction, 90%; 2-in. obstruction, 150%.

Similar percentages for main truss members are also given in the detailed tables accompanying the report. They are omitted above not because the results do not command confidence but because they are few in number and because the unit stresses are so small that they are not representative of fully loaded structures.

Comparison of Observed and Computed Stresses in Other Members

Static load stresses were computed at all points at which they were observed and for identical loads. Close comparisons are not expected for three reasons:

1. Observed stresses were not taken at a sufficient number of points in the cross section of each member to represent the average distribution.

2. A high degree of precision can not be expected in observed stresses. It is believed that all of the averages are within 500 lbs. per sq. in. and that many of them are within 200 lbs.

3. A high degree of precision in the computed stresses can not be expected because of the effect of the continuous steel and concrete floor. The results give strong indication that the floor relieves the lower chords of a considerable portion of their tension, raises the plane of bottom tension, and thereby reduces the effective depth of the truss and increases the compression in the upper chords. It is also likely that the web members are affected by the shear in the floor and that the general distributing power and continuity of the floor still further affects the stresses throughout the structure.

Future Work

Ultimately the work on this problem should lead to the acquisition of data which will give in terms of impact the effect of various tires, conditions of tires, chains, etc. The immediate problem, obviously, is not to continue until all of these possibilities have been investigated for all types of floors, but so to standardize the conditions already used as to serve as a means of interpreting other conditions.

This standardization may consist in establishing a relation between the impact stress and the simultaneous force of the blow of the truck wheels on the bridge floor. After this has been done the work of the United States Bureau of Public Roads, in which by the compression of copper cylinders, use of accelerometers, etc., the force of impact blows has been determined, may be used to estimate the impact stresses in a bridge to which such impacts are delivered.

Putting In Traffic Lines With White Mix

Traffic lines of white cement required in Pennsylvania specifications for concrete highways may be said to be as yet in an experimental stage with serious doubt as to the wear and weather resisting qualities of those already placed. The highway between York and Dallastown, Pa., opened to traffic in October is a good example of a completed job.

The traffic lines were made of white cement and white sand, 4 in. wide and 1 in. thick. They were placed as the finishing machine advanced within 24 hours after the concrete for the road was placed. Back of the finishing machine a board 1 in. thick and 4 in. wide was forced into the wet mass. Before the concrete was hard the white sand and cement mixture was placed in the depression made by the board and finished by hand.

Twenty-five cents a foot was paid the contractor for placing the traffic lines.

It has been found that these lines soon develop numerous cracks and the question now is now long they will stand the contraction and expansion of cold and heat and the destructive forces of freezing, because the rich cement and sand mixture in the white lines does not contract and expand uniformly with the rest of the paving.

Numerous experiments are being conducted by engineers to devise a method for placing these white cement lines more quickly and to arrive at a mixture and method of construction that will prevent cracking such as now is causing the trouble. A method of placing broken lines like large dashes somewhat avoids the many cracks as found in the continuous lines. But where that plan has been tried the white cement is now breaking out although the road has not been in use much more than a year.

New Course in Construction at Yale

An optional course in building construction open to students in civil engineering, has been established at Yale University through the generosity of Louis J. and Mary E. Horowitz of New York. The aim of this course is to train the student in the fundamentals of buildings construction. It is not a course in architecture, nor is it primarily a course in structural design as applied to building. It is rather a course intended to prepare the student to enter upon the work of the actual construction of modern buildings, particularly buildings on a large scale, and to give him both a basic and practical knowledge of building methods and the management of building operations, in order to lay a broad foundation for future executive work in the field of building construction.

The course includes, in the freshman and sophomore years, English, history, economics, and the fundamental sciences. During junior and senior years are covered the general engineering studies of a civil engineering course combined with architectural design, specializing in the problems of building construction, the intent being to furnish both a fundamental and practical training in this field. Besides the studies dealing with the actual problems of design and construction, the curriculum includes courses in business law and accounting, and in fact, the entire work is planned so as to combine both the professional and business sides of the industry for which the students are being prepared.

The detailed work of the studies in building construction divides into fourteen subjects commencing with a study of building materials, carried on in conjunction with the usual laboratory tests, supplemented by practical demonstrations of the more widely used building materials. This work is followed by a discussion of the restrictions and requirements imposed by various codes and rulings, state and municipal laws, insurance underwriters and similar authorities. Prior to the actual work of structural design, which goes hand in hand with an elementary architectural course, a comparative study is made of the various types of buildings as distinguished by their construction, emphasis being laid upon the suitability of different types to meet specific purposes, both for buildings as a whole and for their constituent structural parts. These lectures are illustrated by plans loaned by architects and engineers and by photographs of current operations, the more important of which are reproduced in the form of lantern slides. As illustrative problems the student chooses and roughly sketches the most suitable construction to meet given architectural requirements, conditions of location and occupancy.

There is work in the structural design of buildings; specifications and contracts; estimating and cost analysis; purchasing materials and the preparation of subcontracts; and construction methods as applied to field work. This last is an enormous field and can only be taught after a thorough analysis has separated the important principles of management and coordination from the mass of seemingly uncorrelated operations in evidence upon an active job. As in the case of the general subject, the student is given, first, a background of information, and then led on to the fundamental principles of job organization, such as the proper sequence of operations, the relation of plant to personnel and the balancing of the various labor units. Finally, he is given practical knowledge of the most efficient methods of construction in the various fields covered by the principal building trades. In this work we have the cooperation of many of the largest and most successful contracting organizations in America and are equipped to teach the best present day practice.

One of the interesting features of this course is the tour of inspection made in the vicinity of New York during the first two weeks of September preceding the Senior year. The purpose of this visit, under the personal supervision of an instructor, is to trace, step by step, the progress of the work upon typical building operations from the point where the architect receives the first general information from the owner, to the office of the engineer who develops the structural drawings and then through the contractor's organization, to the actual jobs. In this way is obtained a bird's eye view of the entire operation and many prominent architects and engineers are cooperating to the extent of opening their offices to the class, and even personally describing their own work.

New Thames River Bridge

The progress of concrete in the bridge building industry of Europe is well known, and much has been written of the famous French example. It is not so generally known however that year by year concrete takes a firmer hold on this work so far as Great Britain is concerned, and a new bridge over the Thames river of this material is promised. The work is to be started immediately. The new bridge which will be entirely constructed from reinforced concrete will be the third of this material over the Thames river. It will be in the Renaissance style, but with squared rubble towers, to obviate conflict with the Norman architectural surroundings. The bridge when finished will bear the Royal Arms.

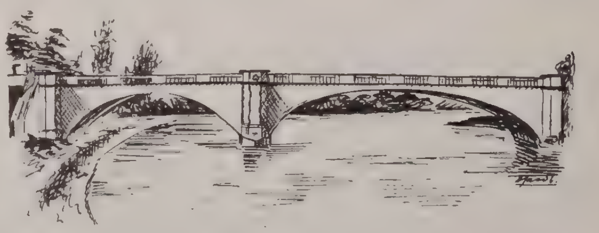


Fig. 1—Sketch of new bridge over Thames river

It will consist of two unequal span arches, on the Berkshire side one of 75 ft. and one of 110 ft. on the Buckinghamshire side with a center cutwater pier 15 ft. wide, and is designed to carry all classes of modern traffic. It will be built on the principle of the Trussed Concrete Steel Co. Ltd. The work will be undertaken by the contractors Messrs. A. Jackaman & Son, of Slough, Buckinghamshire. The cost is to be borne by the Transport ministry as well as the two county councils concerned.

Graded Aggregate

Weather and Construction

A pamphlet entitled *Weather and Construction* has been prepared by the Division of Building and Housing Departments of Commerce, for the use of those concerned in carrying on building operations during the winter months. The detailed figures which were gathered for nine cities may be used in a general way for a large proportion of all cities in the United States by selecting, through the aid of the local weather bureau, the city or cities with conditions most nearly similar; or cities may adopt the more satisfactory course of preparing similar tables based exactly on their own conditions. The text of the pamphlet aims to give a full explanation of the tables as a practical aid to contractors, architects, engineers and others.

* * *

Waterproofing Stone

The superiority of paraffin treatments for waterproofing stone has been demonstrated by a weathering test of colorless waterproofing compounds conducted at the Bureau of Standards, Department of Commerce, during the past three years. says a Bureau announcement. Samples of Indiana limestone and of sandstone have been used in the tests, one half of each specimen being coated with the waterproofing compound while the other half was left untreated.

Very little deterioration was noticed in the case of the paraffin treatments during the period of the test. Materials using aluminum stearate and mixtures of paraffin and china wood oil were also found to give good waterproofing values when properly applied. Materials consisting of solutions of glue, magnesium fluosilicate, cellulose nitrate, resins, etc. are not sufficiently durable to justify their use, in the opinion of the Bureau.

Most of the materials tried discolored the stone to a considerable extent at first, depending on the porosity of the stone. Very dense types were not appreciably discolored while very porpous ones appeared greasy for several months after treatment. After a year or more of weathering the discoloration disappeared and the treated surface appeared lighter and cleaner than the untreated.

A new series of tests is being started with these materials on dense limestones and marbles. A new compound has recently come into use in England which consists of a silicon ester. This material is being included in the tests.

As to silicon ester[1] CONCRETE has the following from Dr. A. P. Laurie, Heriot-Watt College, Edinburgh, Scotland:

> It is a solution of silicon ester in a volatile medium such as alcohol and when applied to stone it hydrolyzes after evaporation of the volatile medium and deposits a cement of hydrated silica around the particles of the stone.
>
> It is intended in the first place for the treatment of valuable decaying moldings and carvings in this country which require to be recemented together. In the second place it has a distinctly protective value for limestones and calcareous sandstones, diminishing the rates of attack of sulfur acids.
>
> It is not intended to be a waterproofing medium as our experience under the climatic conditions existing in this country, and more especially owing to the wide prevalence of sulfur dioxide forming calcium sulfate which crystallizes within the stone, is that anything which closes the pores of the stone results in scaling and mischief unless that closing be of the nature of absolute sealing such as coats of oil paint renewed from time to time.
>
> Apparently in America you are in search of waterproofing mediums, or rather partial waterproofing mediums, as even boiling in paraffin wax does not protect a limestone from attack by hydrochloric acid vapor. These may be the right lines for the United States but they are not the right lines for this country. Please therefore do not regard silicon ester as a waterproofing medium.

* * *

The Selection of Contractors

A statement on the selection of general contractors and sub-contractors identical with a similar document recently issued by the Boston Building Congress and which has also been recommended for adoption to the New York Building Congress by its code committee, has been issued by the Philadelphia Building Congress for the information of owners, architects, and engineers in the interest of the building industry and the efficient, economical and workmanlike execution of contracts. The following procedure is recommended for adoption in securing estimates and awarding contracts:

(1) Do not ask for competitive approximate estimates unless adequately paid for.

(2) Furnish complete, clear and accurate plans and specifications when asking for bids.

(3) Invite only a limited number of contractors to compete, six generally providing adequate competition.

(4) Invite for a given piece of work contractors of substantially equal ability and standing.

(5) Invite only contractors to whom you are willing to award the contract.

(6) Having invited bids as provided above, award the work to the low bidder, unless other considerations than price are to enter into the award in which case make this fact perfectly clear in the notice to bidders.

(7) Where the time for the completion of the work is important, name a definite time, on which all bids shall be based. Do not invite bidders to name their own time limits as well as their prices.

(8) Eliminate as far as possible unit prices, alternate estimates and secondary estimates when asking for bids.

(9) Do not award a general contract without determining in advance the subcontractors to be used on the principal portions of the work.

(10) In order to determine sub-contractors in advance follow one of the following methods or a combination: (a) provide that the general bidders shall name the principal sub-contractors they intend to use in their proposals; (b) submit to the general bidders a list of approved contractors for such important sub-contracts; (c) secure principal sub-bids and send a list of designated names and amounts to all general bidders to be incorporated in their bids.

(11) Where work is covered by allowances to be adjusted after the general contract has been awarded, reduce such items to the practicable minimum, and do not include under "allowances" sub-contracts of major importance.

(12) In selecting bidders for designated bids, or allowances, or for separate contracts, give due consideration to their labor policy, according to the policy adopted for the general contract.

* * *

Free Nation-Wide Employment Service

The establishment of a free nation-wide public employment service, maintained by the states in cooperation with the federal and local governments, for the benefit of men, women, and juniors in all walks of life, is recommended by the Russell Sage Foundation in a 600-page report on employment methods, needs, and agencies, made public as the result of a five-year study which took the Foundation's investigators into more than 70 cities of the United States and Canada.

* * *

Deterioration of Sheet Lead in Contact With Portland Mortar and Concrete

A number of requests are received at the Bureau of Standards from time to time for information on the question of the deterioration of sheet lead when in contact with portland cement mortar and concrete. Some two years ago this question came up in connection with lead sheathing on power cables and in cooperation with an electrical power company a few exposure tests were made on specimens of lead sheathed cables.

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[1] Manufactured by Allright & Wilson, Oldbury near Birmingham, England.

Six pieces of cable about one foot long and with one end soldered were imbedded to a depth of nine inches in a stiff portland cement mortar made of one part cement and two parts sand. The mortar coating was ¾ in. thick and the soldered ends were placed in the mortar. Three specimens were coated with plain mortar and three were set in mortar containing 2% of pulverized sodium silicate (percent by weight of cement). One of each type of specimen was stored under three conditions of storage, as follows: air of the laboratory, the specimen being wetted occasionally; immersion in water to within one inch of the top of the mortar; and moist air of a damp closet.

After two years and three months exposure to these conditions the mortar coating was removed and the lead sheathing examined. The specimens under dry storage were practically unaffected with the exception of a very slight yellowish tinge on the surface of the lead. The specimens stored in water showed only a trace of oxide near the top line but were free from this over most of the surface. There was apparently some electrolytic action near the soldered end where the lead was bright and slightly surface eaten or pitted. The specimen encased in the plain mortar showed slightly more attack than the sodium silicate mortar specimen. The two specimens in the damp closet were more or less covered with a hard but thin coating of yellow oxide. The coating on the plain specimen was slightly heavier than on the sodium silicate specimen especially near the top and bottom. Signs of pitting were apparent only in one area on the plain specimen.

These limited tests show that corrosion of lead occurred in contact with the mortar and that the addition of the sodium silicate to the mortar did not make a marked difference in results.

In view of the wide use of sheet lead in shower bath work, the Bureau makes the following suggestions:

> That not lighter than six pound lead be used and that the sides be turned up at least two inches above the floor level. The corners should be turned up and not soldered. The concrete base upon which the lead pan is laid should have a smooth finish and be given a coating of bituminous paint before the pan is set. The top of the pan should have a similar coat before the topping is laid. The topping used above the pan should be a 1:3 cement sand mortar and during the laying of this care should be taken to protect the weep holes in the trap by some means as placing a layer of gravel about ⅜ in. size around the trap for a considerable area.

* * *

Use of Hydrated Lime in Portland Cement Mortar

It is quite common practice to add hydrated lime to portland cement mortar, to improve its working qualities, while on the other hand portland cement is added to lime mortar to hasten its set and increase its strength. The quantities of each material vary with the locality and the opinion of the user, according to a Bureau of Standards announcement. Obviously there is a mix best adapted for given conditions. The determination of these mixes has been the subject of many investigations covering a number of years. An investigation has been completed at the Bureau dealing with the measurement of plasticity, time of set, yield, shrinkage, and tensile strength, together with a resume of the literature upon these subjects. Many interesting points have been brought out, including:

(1) The richer the cement mortars, and the higher the percentage of lime which they contain, the more mixing water is required to bring them to a given consistency.

(2) A cement mortar to which lime has been added requires additional water, but this additional water increases shrinkage possibilities; therefore lime should be limited in cement mortars where it is desirable to keep the shrinkage low. The principal advantages of the lime are that it increases workability tends to prevent segregation and may reduce permeability if used in the proper proportion. Lime retards the set of cement mortars.

(3) The substitution of lime for an equal volume of cement always results in a decrease in strength. The substitution of lime for an equal weight of cement can not be expected to increase the strength of a cement mortar which is richer than 1:4.

(4) The desirable properties of cement-gaged lime mortar are short time of set, strength, elasticity, and workability.

A study of the literature indicates that: Inert, powdered admixtures possess positive merit for reducing permeability of mortars to water when applied to mortars that are not too rich; the strongest mortars may not always have the greatest adhesion; extra sand reduces adhesion of mortars; the strength of masonry depends upon the strengths of brick, mortar, and bond between mortar and brick.

* * *

Impact Stress in Concrete Stadium

While planning repairs for a large reinforced concrete stadium the question arose as to whether the girders possessed sufficient strength to permit adding a considerable dead weight to the present structure. Extensive load tests carried out recently showed extremely slight deflections and indicated ample strength when static load was considered. Application was made to the Bureau of Standards for a test to determine whether moving loads causing impact and rythmic deflections would set up stresses great enough to reverse the conclusions based upon static loads. For this purpose electric telemeters of the type described in Technologic Paper 247, were used, and observations of stresses in the reinforcement of beams and girders were made during the entire progress of a recent foot ball game when the stadium was loaded to full capacity. The results have not been fully studied but it is clear that stresses due to all causes were very low. The indication is that the static live load stress in the steel did not exceed one thousand pounds per square inch and that the stress due to impact or moving load of any kind did not exceed three hundred pounds per square inch. The instrument apparently behaved well and no reason is known for doubting the indications from the tests. These results will probably prove an important contribution to available information regarding behavior of such a structure under loads causing impact. Caution is needed, however, in applying such results in other cases. A structure having less weight or a different period of vibration might show a greater stress.

* * *

Hollow Tile Walls Given Fire Test

Hollow building tile having double shells on the two exposed sides give very good results from the point of view of fire protection, the Bureau of Standards finds. The exposed shell serves as a protection for the rest of the tile, and in order to distribute the stresses properly, the webs connecting this outer shell with the inner wall of the tile should be thinner or less in number than the webs back of the inner wall.

Gypsum and portland cement plaster coatings over hollow tile will stay in place during ordinary fire exposure and will give about the same protection from fire as the addition of one wall and cell to the thickness of the tile.

The addition of a combustible filler, such as sawdust, to the clay in amounts from 5 to 15% by volume, decreases the cracking of the burnt tile when exposed to fire, but has the disadvantage of producing a decrease in strength for the larger amounts of filler, thus lessening the ability of the tile to carry load under fire exposure.

More than 100 tests of small tile panels have been made, the panels forming one side of a special furnace. Eight tests have been made on walls 11 x 16 ft., and these are the first of a series of 50 fire tests to be conducted on hollow tile walls in the near future. Some of these walls will be tested restrained by the heavy panel frame as they would be if supported by cross walls during an actual fire. Others will be unrestrained, being supported only at the bottom. In some of the tests the walls will carry their normal working load.

Other points found to add to the quality of tile are sufficiently fine grinding of the raw material, the even burning of the clay to normal hardness for that particular clay, the provision of sufficiently heavy shells and webs, and the use of ample fillets where the webs join the shell.

* * *

Ohio Products Manufacturers

The annual meeting of the Ohio Concrete Products Association is to be held in Cleveland at the Cleveland Hotel, January 13, 14 and 15. It is important that every concrete products manufacturer of Ohio attend this meeting, to discuss the proposed new Ohio State Building Regulations relating to concrete products.

* * *

Convention of Products Manufacturers

A national convention of the Concrete Products Association—the first national meeting in several years—has been called for January 28, 29 and 30 at Hotel Wisconsin, Milwaukee. Joint sessions with the Wisconsin Concrete Products Association assure a live and progressive nucleus. As CONCRETE goes to press no program has been received.

Several of the state and local concrete products organizations have been very active and have accomplished a good deal in their respective territories.

Their most valuable work has been in cooperation with state and municipal building authorities in enforcing regulations and to this end and chiefly through field men of the Portland Cement Association the local manufacturers have been helped a great deal to apply to their operations the better technical knowledge of quality control in concrete, much of which has been developed and made available through committees of the American Concrete Institute. Local organizations have also been active in purely promotional work by cooperative selling of the idea of concrete masonry.

There are thousands of producers of concrete masonry units and a few hundred progressive ones who have the vision to see their industry from a broad viewpoint—the necessity for building up morale in their own ranks, respect for high technical standards, and a desire to build up their industry for some larger success than next spring's production and sales.

A great deal can yet be done through local and state organizations to clean up the business for it still needs cleaning up and with good leadership a national organization can help a great deal.

A considerable number of the more progressive manufacturers—and the ranks of this type have been filing up lately with a better type of business and technically trained men—have recognized in the American Concrete Institute a means of building up their business by technical knowledge of good concrete. They have seen that the problems of making good concrete products are the problems of making good concrete, and that a technical alliance with the best men in that whole field is a fundamental necessity for growth.

There remains a good deal of work that cannot now be done through the American Concrete Institute which is in no sense a trade or commercial organization and a large part of that work is in extending the application of good technical knowledge throughout the industry among men who will not attend the Institute meetings because purely trade discussion is barred.

Let every progressive manufacturer get behind this new movement to give the National Concrete Products Association more definite and active meaning to the industry.

The Business Future

A forecast of the business future must be simply a weighing of the economic and political forces in motion, says Secretary Hoover, Department of Commerce. The annual survey of the Department of Commerce shows that the New Year begins with the economic structure of the world upon more solid foundations than at any time since the war. With the exception of a few spots of secondary importance there has been during the past year a real advance toward social, economic, and political stability throughout the world. The only exceptions are Russia and China, which even before the war contributed less than 3½% of international commerce and of course a part of this continues. Generally the world is producing more goods, there is fuller employment, there are higher standards of living, more assurance of economic stability for the future and more promise of peace than we have seen for many years. The world is by no means free from liability to economic shock, yet the forces today in motion all tend to great promise for the forthcoming year.

In our own country the outstanding economic development of the year has been the very large recovery in agriculture after its two year lag behind the recovery of industry. The farmers have a large measure of losses in the last three years yet to recover, but their outlook is encouraging. There are some secondary difficulties still remaining, particularly in the cattle industry and the effect of the subnormal corn crop; but the prices of all farm products are gradually moving toward the general average of commodity prices. This improvement in prices of farm products has been parallel with some decrease in the prices of many industrial commodities, such as fuel, building materials, metals, etc., so that there has been little change in the average of all price levels, and thus the farmers' purchasing power is being remedied in both directions.

While there has been a good deal of adjustment in prices of single commodities during the year, the average wholesale price of all commodities has varied but 3% between the ends of the years 1922, 1923, and 1924. It would thus appear that we are tending to the common level in prices of about 50% over pre-war, which seems to represent at least our present economic plane of prices.

The average wage in industry has been stable during the last year, and remains around 100% above pre-war, while the cost of living has maintained almost exactly the same level at the end of each of the last three years, 1922, 1923 and 1924, about 72% over pre-war. Our labor, therefore, continues to enjoy the highest real wage in its history.

The construction work of the country has maintained high activity. While the shortage, particularly of housing and business buildings, due to the cessation of construction during the war, has been to a large degree overcome, yet continued high real wages and general prosperity create a demand in excess of that due only to increasing population, because of the insistance of a population of rising standards of living, for more elbow room and better housing generally.

One striking factor in maintenance of increased construction activities is the effect which the automobile is producing in increasing the demand for road construction and in causing migration of population in many of our towns to new housing in the suburbs. Another effect of these forces is to maintain rents out of line above the general price levels. With our high real wages and little unemployment there is no reason to expect any material change in the course of this industry.

Our railroads have shown continued increase in efficiency during the year, and have now proved themselves equal to any burden which is likely to be thrown upon them. Motor transportation continues to develop and to enter more and more into the vital economic life of the country—in fact, almost imperceptibly our road improvement programs are taking on the complexion of new transportation systems.

Our foreign trade has shown considerable expansion during the year in exports, and some decrease in imports.

It has been suggested in some press quarters at home and abroad that the result of these favorable factors may be leading our country toward a period of inflation of the character of 1919-20 with its disaster of 1921. It can be assuredly stated that we are on the march of wholesome recovery from the war and there is no present indication of inflation. We only secure inflation when undue expansion of credit finds its outlet in bidding up prices after the plant and labor capacity of the country is employed to the maximum.

* * *

A. G. C. Meeting

The sixth annual meeting of the Associated General Contractors of America will be held in Washington, D. C., January 12, 13 and 14. Subjects to be covered include practically every situation and problem with which constructors are forced to deal in the course of their operations.

* * *

Value of Road Research

At the fourth annual meeting of the Highway Research Board, at Washington, D. C., December 4 and 5, Thomas H. MacDonald, Chief, Bureau of Public Roads, one of the Directors of the Highway Research Board, discussed the Financial Value of Highway Research, pointing out that "a discussion of such a topic ought to introduce a note of practical application of those scientific principles and facts which we arrive at through research and through investigation and ought to bring out their actual value in dollars and cents to the people of the United States."

One example is the use of the thickened edge in the design of concrete roads. By this design which is the result of an extended research, a saving has been made of about 390 cu. yds. of concrete per mile. At ten dollars per cubic yard this is a saving of $3,900 per mile. There are 24 states that have adopted this new design. If, in these states, 2400 miles of concrete roads are constructed per year the saving effected amounts to $9,360,000. By intensive laboratory research the Iowa Highway Commission has been able to develop means of appropriately using non-standard aggregate in concrete construction. In building 74.35 miles of concrete pavement during 1920 and 1921, $155,638 were saved to the state through the successful work of its laboratory.

* * *

Standardization

Charles E. Skinner, a representative of the American Institute of Electrical Engineers, was elected chairman of the American Engineering Standards Committee for 1925, and Charles Rufus Harte, representative of the American Electric Railway Association, was elected vice-chairman.

Notable developments in the industrial standardization movement, including important progress in the mechanical and mining industries, and in the safety field, its further extension into managerial and trade association activities both here and in Europe, and steps looking toward it in Latin America, have taken place during 1924.

* * *

Detroit Engineers Discuss Aggregate Variations

The subject of concrete in general was discussed from the viewpoint of the aggregate producer, the engineer and the contractor at the meeting of the Detroit Engineering Society, December 19, 1924. Interesting local conditions mentioned included the use by engineers of numerous different specifications for the aggregates that go into the concrete. Standardization of the specifications for aggregates was recommended.

In speaking for the material producer, L. E. Williams, engineer for the United Fuel & Supply Co., outlined some of the difficulties met with in producing aggregates to meet all specifications. Preparation of pit gravel in the vicinity of Detroit includes cleaning and sizing, washing, and where clay is present, the hand picking to remove the clay while dry. A 100% separation of the gravel is practically impossible unless the material is bone dry.

In the interpretation of various specifications as to grading of aggregates, the material producers have found that particularly with the larger sizes, the engineers who wrote the specifications often had different sizes in mind even though the same sizes were specified, depending upon whether square mesh sieves or round punched plates were to be used.

The segregation of gravel in the car during shipment has been found to cause a variation of 33⅓% in the proportion of coarse material when comparing samples taken from the loading belt conveyor at the yard with samples taken at random from the car when it arrived on the job.

From the engineer's standpoint, it was pointed out that the concrete designer does not always get the strengths he designs for, due to variations in aggregate, proportions of cement and water used and insufficient mixing as well as carelessness in placing reinforcing steel. Tests of samples of concrete as found on the job were referred to where the results were 60% below specifications, but load tests of the structures indicated results better than specified.

A paper by J. H. Wasson on the effect of violation of fundamental principles for making good concrete is presented elsewhere in this issue.

Books

American Society for Testing Materials Standards, by the American Society for Testing Materials, Philadelphia, Pa. 1230 pp.; illustrated. Price to non-members, cloth, $11.00, half leather, $12.50. To members for extra copies, $8.00 and $9.50 respectively.

The A. S. T. M. standards is issued triennially. The 1924 edition containing 220 standards adopted by the Society has just been issued. It includes standard specifications, methods of tests, definition of terms, and recommended practice in effect at the time of publication.

The Society publishes standards one or more years as tentative standards before giving them formal approval. The new volume contains 29 standards relating to cement lime, gypsum and clay products. These include standard specifications for: portland cement; cement-concrete sewer pipe; hydrated lime for structural purposes; gypsum plasters; fire tests of materials of construction. They also include standard methods of tests for unit weight of aggregate for concrete; test for voids in fine aggregate; making and storing specimens of concrete in the field; test for organic impurities in sands for concrete; test for sieve analysis of aggregates for concrete.

The Building Labor Calculator by Gordon M. Tamblyn, a loose leaf pocket book, page size, 4 in. x 6¾ in.; flexible binding; Price $10.00; published by Gordon M. Tamblyn, Denver, Colo.

This is a book that fits the pocket and is for use on the desk when estimating a job. It is to be carried in the pocket so as to be available at a moment's notice, in the office, on the job or when as successful bidder, the contractor is called upon to allow for certain eleventh hour changes in plans which can be covered off hand from the calculator with the assurance that the figures are right.

The Building Labor Calculator is based on this fundamental principle, that the average output of the average American workman is constant and will be the same in any place where American construction methods and American workmen are used. The number of hours required to do a given piece of work are given in the calculator and in order to arrive at the labor cost of that piece of work, it is only necessary to multiply the given constant by the wages paid for that kind of work in the particular locality concerned.

Among the different subjects on which The Building Labor Calculator gives the labor hours are: excavation, sheet piling, concrete and cement work, concrete forms, reinforcing steel, brick work, stone and architectural terra cotta, tile and plaster block partitions, rough carpentry, lathing and metal furring, plastering, finish carpentry, interior marble, sheet metal work, heating, roofing, painting and varnishing, job organization, cost analysis. Under the heading, "Concrete and Cement Work" the labor required for mixing by hand or with mixers is given and the hours of common labor and all other workmen on the job, whether a single cubic yard or 5000 cu. yds. of concrete are involved. It also gives the amount of cement, sand and gravel or crushed rock required for any mix likely to be used. Under the heading "Concrete Forms" are given the material and labor hours on all of the members met with in concrete and reinforced concrete construction.

Structural Engineering, Fundamental Properties of Materials, by George Fillmore Swain, 200 pp; illustrated; size, 6 in. x 9½ in.; Price $2.50. McGraw-Hill Book Co., New York City.

This volume is a companion to the author's *Strength of Materials* and the second volume of a series on the theory and design of structures. The fundamental properties, the constitution and physical structure of the principal materials important to the practicing engineer are discussed from the point of view of the engineer. The book describes the importance and effect of various ingredients, the effect of different treatments, and the significance of the specifications used to secure desired properties in the materials to be employed by the structural engineer, including wood, iron and steel, cast iron, wrought iron, alloy steels, non ferrous metals and alloys, stone, brick and other clay products and calcerous cements and concrete.

A chapter on Corrosion of Metals points out the importance of protecting wood and metal in structures from decay and corrosion. In this connection, the importance of paints and varnishes is touched upon.

This book is recommended to the structural engineer, who, being a designer and constructor, must use materials and must therefore be familiar with their methods of manufacture, properties and strength in order to enable him to frame his own specifications where they have not been standardized.

Heltzel Batch Box

A new batch box is produced by The Heltzel Steel Form & Iron Co. Warren, Ohio. The boxes are all-steel construction, with all top edges reinforced with double steel flanges, not only affording an absolutely rigid construction all around but also providing permanent holds for easy handling by two men.

The steel construction permits of a fire being built under the batch box in cold weather, to keep the materials from freezing.

Although these boxes are riveted throughout, there isn't a rivet inside the box to catch the mixing tools, and the bottom is made in one piece, smooth and seamless, without any possible place for mortar to adhere and harden.

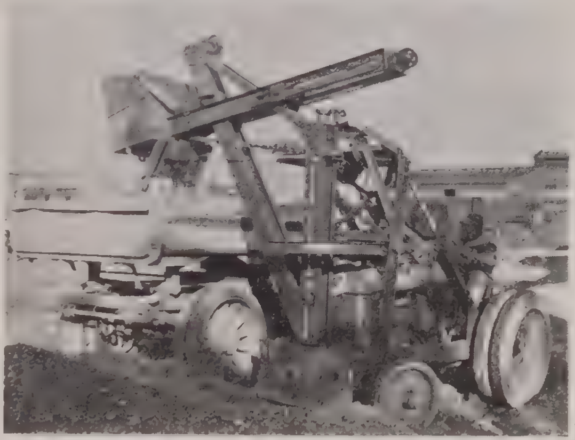
Boxes are in three sizes, No. 1, 5 ft. long x 2 ft. 4 in. wide, of 14-gauge steel and weighing 80 lbs.; No. 2, 7 ft. 6 in. long x 3 ft. 6 in. wide, of 14-gauge steel and weighing 140 lbs.; No. 3, 11 ft. 6 in. long x 4 ft. wide, of 12-gauge steel, weighing 350 lbs. All three sizes are 10 in. deep.

Any one of these three sizes can be furnished with a steel saddle to which is bolted a hod support which slides along the side of the box to any location desired.

It is claimed by the Heltzel company that these boxes will outlast a dozen wooden boxes and that, in addition, they afford the advantages of easier handling and the steel hod support and ability to build a fire under them.

Fordson Tractor Power Shovel

Glasgow dig-a-load is special equipment mounted on a Fordson tractor to make it work like a steam shovel. See the picture. It has a ¼-yd. dipper, and is said by the manufacturer to have a capacity of 30 tons an hour. The equipment consists of this bucket or dipper mounted on a pair of dipper sticks, which are carried on a very heavy structural steel framework, mounted on the tractor. The action is similar to that of a baby steam shovel, except that it is preferable to back the tractor about 4 ft. from the pile of material to be handled, and then run forward into the pile before hoisting the dipper. The dipper is raised by a cable, which runs back to the main hoisting drum and is made to dig into the ground or crowd into a pile by the action of the cable, which is looped over a sheave on the upper end of the dipper sticks. There is a side-swinging motion too, which is controlled through two cables, which are run from each side of the bull wheel back to two small drums on the main power shaft. The manufacturers recommend the equipment for use in loading stone in quarries into skip-cars going to crushers; in handling piles of loose rock, gravel, or sand into trucks; and to fill the skips of concrete mixers through the use of an intermediate batch hopper. They do not recommend their use on sand or mud.



New Haiss Equipment

A new adaptation of the Fordson tractor has been brought out as the Haiss Fordson Tractor by the George Haiss Manufacturing Co., Inc., New York. Dismounting the four wheels, the Haiss caterpillar traction links are installed to give the machine better ability to go over uneven ground. The length of the equipment is 8 ft.; width 6 ft.; height 4 ft. 10 in.; length of track ground 4 ft. 6 in.; ground clearness 12 in.; tread of track 5 ft. 10 in.; weight about 4,000 lb. It has three speeds and one reverse—.8 miles an hour; 1.47; 3.63 and reverse 1.41 miles an hour.

A wheel equipped Fordson loader which varies from the old type in the fact that it can be propelled into the pile of material while the elevator is in action, has been brought out also by Haiss. The new feature is obtained by the installation of a cast steel take-off box between the flywheel and the clutch of the Fordson tractor. The tractor is disconnected in the center by taking the bolts out of the flywheel housing and installing the Haiss take-off box and attaching the rear end to the box. This puts the clutch behind the take-off so that when it is desired to propel the machine into the pile the elevator clutch is not disconnected.

The accompanying picture shows the use of a Haiss loader in excavating alleys for paving. This work was done by Frenzel Brothers Co., Chicago. Two of these scraper loaders were employed. The material was sand, ashes and soil

Haiss loader on alley job

generally from cellar excavations. The alleys were loosened with a rooter plow which also served to uncover rocks or other material needing separate attention. The loader travels along the middle of the alley which may be from 9 to 16 ft. wide, and laborers throw the material from the sides into the path of the feeding propeller. Four- and 6-yard trucks back under the loader for their loads and drive out; in one period of 28 minutes it was reported that 40 yards were placed in trucks with one loader.

Novo Centrifugal Pump

The accompanying illustration shows a Novo direct connected centrifugal pumping outfit, one of the new outfits powered with Novo multi-cylinder engines recently added to the centrifugal pump units heretofore manufactured by the Novo Engine Co., Lansing, Mich. The centrifugal outfits are recommended by the manufacturers as providing the simplest method of handling large quantities of water. They require little attention and operate with practically no vibration.

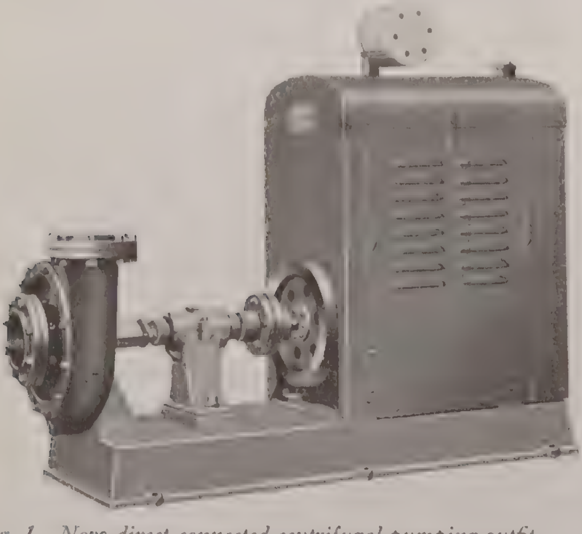


Fig. 1—Novo direct connected centrifugal pumping outfit

It is pointed out in connection with this equipment that it is very important when installing a centrifugal pump to place the outfit not more than 18 or 20 ft. above the water supply.

Other equipment included in the recent addition to the Novo line include a direct connected centrifugal outfit designed for higher head and greater efficiency, a pumping outfit for irrigation and a direct connected and chain driven centrifugal outfit fitted with Novo single cylinder engine.

Trailer-Mounted Mixer Saved Time in Pouring Lamp Post Bases

In concreting lamp post bases, the time ordinarily lost in moving the mixer from one set-up to the next, and getting ready to pour has been reduced to a small item by the Electric Contracting Co. of Chicago by the use of a mixer with a drop-down power loader, mounted on a trailer.

The mixer shown in the accompanying illustration is ready for action as soon as the trailer stops, and ready to move on at once, as soon as the pour is complete. It travels at motor truck speed to any part of the city, and the mixer—a 14-S Marsh-Capron mixer gives a big output and cleans up the work quickly.

In order to enable the discharge of concrete right out of the mixer into dump bodies mounted on Ford trucks, the mixer was blocked up on the trailer. As the illustration shows, the drop-down power loader is filled directly from wheel-barrows on the ground. As is usual with power loader operation, one complete batch is assembled in the power loader while the batch ahead is mixing.

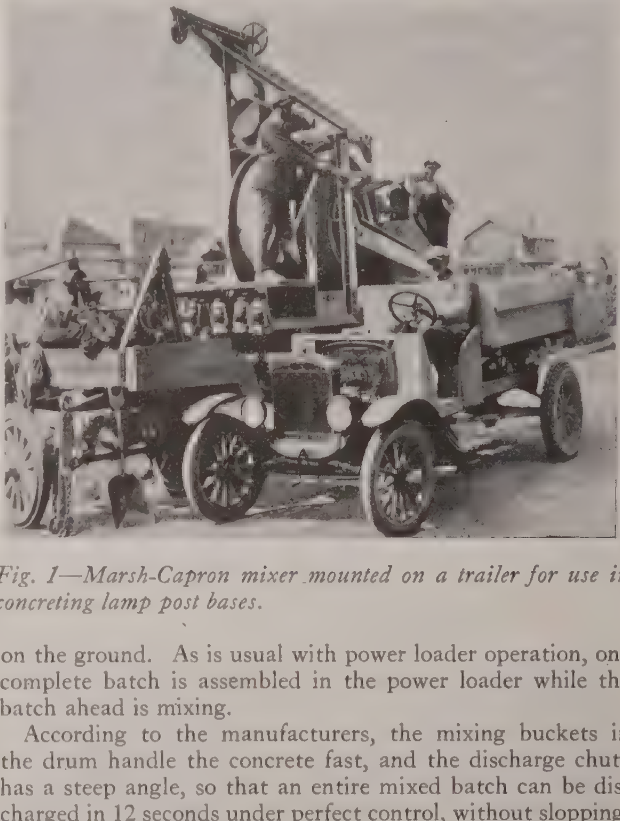
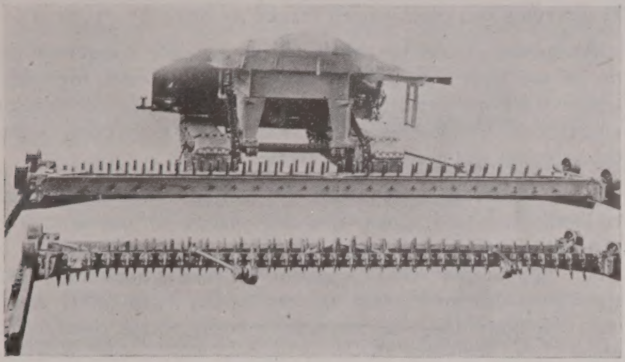


Fig. 1—Marsh-Capron mixer mounted on a trailer for use in concreting lamp post bases.

According to the manufacturers, the mixing buckets in the drum handle the concrete fast, and the discharge chute has a steep angle, so that an entire mixed batch can be discharged in 12 seconds under perfect control, without slopping. Except for the special mounting and drop-down power loader the mixer is a standard Marsh-Capron machine with rail tracks for the main drum bearings, turning on mine-car-wheel rollers.

Koehring Subgrade Planer

The picture shows new road equipment—Koehring subgrade planer, designed to cut down the high spots and fill in low places. It is pulled along by the mixer. It consists of a scarifier and blade scraper spaced about 12 in. apart. The planer is supported on the road forms by two small wheels on each end and is automaticlly moved along by the planer. The scarifier teeth are set a little below the scraper blades so that the high spots will be cut off, leaving the surface in the condition that it can be scraped off to a true and smooth surface by the scraper. The loose dirt retained by the scraper fills in the low spots. In light soil the planer will grade efficiently, the manufacturers say, to a depth of 2 in., but it was not designed to work in hard clay or in old macadam roadbed or one which is shale or rock embedded in large quantities. It is placed either in the rear under the discharge chute, or in front directly back of the charging skip, but it performs to the best advantage under the discharging chute. When in operation the ground men or spreaders mount the grader to give added weight and with ordinary ground conditions the manufacturers say the grade is accurately established while the mixer moves ahead. In more difficult soil the operation can be repeated. The machine is adjustable to all present types of crowns and is built for roads of either 16, 18 or 20 ft. widths. The weight of the 18 ft. machine complete with draw bars is 1410 lbs.



Mechanical Tamper on Bedford, Ohio, Street Pavement

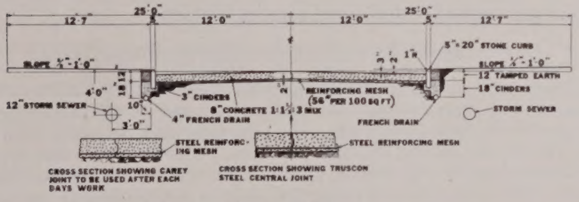


Fig. 1—Cross-section Bedford, Ohio, pavement

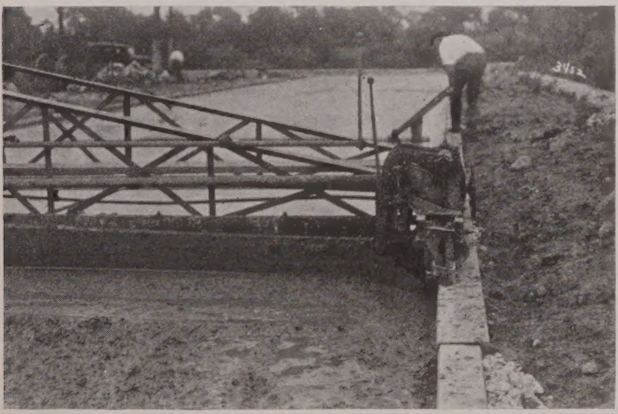


Fig. 2—How surface was finished

The Village of Bedford, Ohio, near Cleveland, has undertaken a good sized program of street construction, and is building a considerable yardage of concrete pavements. Specifications provide that the concrete be spread and tamped mechanically.

A cross-section of the pavement is shown. On some of the construction a concrete curb is placed instead of the stone curb shown, but in any event, the finishing machine for spreading and tamping must travel on the curbs instead of the steel side forms used for rails on ordinary highway construction.

Steel plates, bent to an angle, were laid along the top of the curb to protect it. Four such plates, each about 10 ft. long, were used on each side of the pavement. These are taken up and relaid as the machine advances. The strike-off and tamper of the machine were fitted with extensions, so that they would operate at the required distance below the tops of the curbs.

It was not possible to use the regular finishing belt of the machine, because the curbs did not allow clearance. The final floating of the surface was done with a wood float, extending the full width of the pavement and provided with plow handles on each end. After the mechanical finisher has spread and tamped the slab, one or two trips over with the wood float completes the job.

The result is a slab of greater density, because of the tamping it receives which drives out air and water voids, and with a smoother riding surface than can be obtained by hand methods. B. T. Wright, village engineer, is in charge of the work. Illustrations and information were supplied by the Lakewood Engineering Co.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit, Convention, Chicago, February 24-27, 1925.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agne Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High Street, Columbus, Ohio.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., New York City.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

Steel and Subgrade Factors in Pavement Design

Abstract from a paper by J. T. Pauls, Associate Highway Engineer, United States Bureau of Public Roads, in *Public Roads*.

Observations of the Columbia Pike, an experimental road constructed by the United States Bureau of Public Roads near Arlington, Va., after two and a half years' service under traffic have made possible a number of conclusions with regard to the relation between the cracking of concrete roads and the character of the subgrade and steel reinforcing. The observations also reveal a number of interesting facts with reference to the water-holding properties of the soils composing the subgrades and the relation between these properties and resulting changes in volume.

It is found that subgrade materials with a large percentage of clay not only attain a high moisture content during the wet season but retain a high content during the dry season. Materials of this character subjected to the laboratory test for moisture equivalent will be found to have a high moisture equivalent value. Subgrades having a large percentage of sand do not attain high moisture content. It is also found that subgrade materials composed largely of very fine sand have high capillarity and that under this condition free water will very often be found between the pavement and the subgrade.

Subgrades composed largely of clay swell and contract as moisture is added or taken away. The effect of this in the case of swelling is to lift the pavement at the edges and on contraction to take away the support at the edges. The result is that the slab, acting in one case as a simple beam and in the other as a cantilever, is broken at the center by traffic. The conclusion is drawn from the observations that subgrades that show as much as 10% volume change, by laboratory test on an entire sample including coarse material, should be covered with a layer of coarse granular material, and a pavement laid on a subgrade of this character should have a longitudinal joint at the center. Longitudinal cracks in a pavement indicate an unstable subgrade either as to supporting value or movement caused by moisture changes. Adding a granular material to such a subgrade increases its supporting value and modifies the effect of any volume change. Pavements on this type of subgrade should be designed with a center joint.

The observations made indicate that plain concrete slabs will crack transversely because of temperature and moisture changes at intervals of from 40 to 60 ft. Smooth subgrade surfaces increase the distances between cracks, but the thickness of the concrete does not affect the spacing of the contraction cracks.

Judging by the experience with the experimental sections, pavements reinforced longitudinally will develop transverse contraction cracks, the number, spacing, and size of which will be controlled by a number of factors. If the steel reinforcing is not continuous but is separated by joints, it is to be expected that no cracks will form less than 30 ft. from any joint, and by a suitable relation of the percentage of steel to the length over which the steel is made continuous the distance may be increased to 60 ft. The position of the cracks will be influenced by the strength of the concrete and the roughness of the subgrade as well as by the percentage and continuous length of the steel. If the spacing of the joints is less than twice the distance in which a crack would form, contraction cracking may be entirely prevented. If the distance between joints is extended, a crack may be anticipated at a distance of 30 to 60 ft. from each joint and the area between these cracks may be expected to crack at relatively short intervals. With a high percentage of continuous steel relatively fine, closely spaced cracks may be looked for; with a low percentage, breaks in the steel may be expected to permit wider cracks to form at considerable intervals. Mesh reinforcing in amounts as used in these tests is likely to break at intervals and permit open cracks to form.

Attention should be called to the possible danger of the use of too high a percentage of longitudinal steel, for under such conditions numerous fine transverse cracks will develop and there is the possibility that the narrow transverse beams thus formed will crack under traffic.

From the results obtained on sections reinforced longitudinally it would appear that the practice of omitting contraction joints in pavements of this type is questionable. It would appear that where longitudinal steel is used the design should provide for contraction joints from 50 to 100 ft. apart with the steel designed to prevent intermediate contraction cracks from forming. Another method that would probably be more satisfactory to the contractor, but which might be subject to other objections, would be to make the concrete continuous and to break the steel ½ in. or 1 in. at intervals where it is desired that contraction cracks shall form.

These conclusions will, no doubt, be modified in certain respects and in others made more conclusive as time permits the action of the various factors to become more effective. The results obtained thus far show conclusively the great importance of subgrade investigations in connection with the design of a pavement. Since the character of the subgrade may vary widely in a comparatively short section of road, it seems logical that the design should be modified accordingly so as best to meet the particular subgrade conditions existing, or that the subgrade should be so corrected as to make it suitable for a uniform design of pavement.

A more detailed consideration of the test sections gives these additional conclusions and indications:

Longitudinal Joints Prevent Longitudinal Cracks

Those sections (of the Columbia Pike experimental road) in which longitudinal joints have been constructed are in all cases free of longitudinal cracks, even when the subgrade material, as in sections 10, 15, 24, 26, and 27, changes in volume. There is this distinction, however, that in the section with a high volume change the longitudinal joints are open, showing that more or less movement has taken place at the edge with the joints acting as a hinge; where there has been no volume change, the appearance of the joint indicates little if any movement about the center axis.

Transverse cracks resulting from contraction occur at intervals which correspond to the distance in which the force of subgrade friction becomes greater than the tensile strength of the concrete. Unevenness of the subgrade such as might be obtained by construction of the pavement on rough macadam, for example, increases the number of transverse cracks by increasing the friction between the subgrade and pavement.

An increase in thickness of the pavement does not materially affect the spacing of the transverse cracks as caused by contraction in the pavement. The additional strength of the thicker section is probably balanced by the additional friction on the subgrade. Types of construction of plain concrete which have the section strengthened by additional thickness or thickened edges, although they do not materially affect the spacing of transverse contraction cracks, do serve to keep down the number of additional cracks caused by heavy traffic.

Transverse Cracking Not Prevented by Longitudinal Steel

One of the purposes of this experiment was to investigate the behavior of sections with different kinds and qualities of steel reinforcing. The results obtained to date indicate emphatically that longitudinal steel, above a certain amount and installed as it generally is now, does not prevent transverse cracking but does, on the other hand, greatly increase the number of such cracks.

There is a great difference in the appearance and location of the transverse cracks. In sections where the percentage of longitudinal reinforcing is large, the surface shows transverse cracks every few feet; sections having a higher percentage of steel show a greater number of cracks. In other sections in which the amount of reinforcing is varied, those having eight ¾-in. rods, are not cracked so badly as sections which have a larger number of rods. A section with four 1-in. rods, is cracked slightly less than the sections which have eight ¾-in. rods. Sections with reinforcing varying in amount from four ¾-in. rods to four ½-in. are free from the fine cracks. These sections have open cracks similar to those found in a plain concrete section but spaced at greater distances (60 or 70 ft.). Sections which are reinforced with 25 and 50 lbs. of mesh per 100 sq. ft., have only the open cracks spaced at a greater distance than would ordinarily be found in plain concrete.

From the condition of the reinforced sections it would seem that some doubt can be properly expressed as to the value of longitudinal reinforcing as it is now used in the pavement. The longitudinally reinforced sections in this experiment show conclusively:

1. That longitudinal steel up to a certain amount does increase the spacing of the transverse cracks and that these cracks are open on contraction.

2. That longitudinal steel above this amount will produce fine transverse cracks spaced in some cases only a few feet apart.

Deductions with Regard to Transverse Cracking

The action of these sections and the results of observations on other concrete pavements seem to support the following deductions:

In plain concrete the movement of the pavement in contraction is resisted by the friction between the slab and the subgrade. This force carried to the pavement is very high, much higher than would be expected as the movement is very slow. On the average subgrade it will crack the pavement in tension at intervals from 40 to 60 ft. In cases where the subgrade is rough and offers high resistance to the movement of the slab, transverse cracks will develop at shorter intervals. An extreme case of this was observed when a concrete pavement was laid on a rough natural rock base, the pavement being badly damaged by numerous transverse cracks. It has been observed that the width of these cracks varies directly as the distance between them. In cases where the transverse cracks are close together and very fine, they become wider as time goes on from the grinding and crushing of the edges of the crack. This is particularly apt to occur in cases where the subgrade happens to be unstable.

In case of pavement reinforced longitudinally, the resistance to contraction developed by the subgrade is similar to that in the plain concrete. Aong with this force there is the added force developed by the bond of the steel. Acting against this pair of forces is the force resulting from contraction limited by the tensile strength of the concrete. Taking the case of a slab with continuous reinforcing, we would have as we move from one end toward the other increasing resistance to movement of the slab over the subgrade and increased force from the restrained contraction of the pavement. These forces increase as the distance from the end of the slab or crack is increased until the tensile strength of the concrete is exceeded, producing a transverse crack in the slab. The stress in the concrete is thereby relieved, but the steel remains in tension and continues to oppose the contraction of the concrete beyond the first break. With respect to this section of the concrete the stress in the steel is an initial force to which the subgrade frictional forces are added, with the result that in a comparatively short distance the strength of the concrete is again exceeded and another crack is formed. Repetition of this process produces a series of closely spaced cracks, until the accumulating tensile force ruptures the steel.

If the steel is not continuous and the joints which separate it are close enough together, it is possible that there may be no cracking of the slab. This condition would be expected in pavements which are separated by joints into sections the length of which is less than twice the distance required for the formation of a first crack. There are no such sections in the Columbia Pike, but six of the sections supply evidence of the validity of the above theory. Their first cracks occur about 40 ft. from the joint, while the other intermediate cracks are spaced from 10 to 15 ft. apart.

The effect of accumulating tension in the steel is illustrated by the behavior of sections in which large open cracks have developed. Opening these cracks at points where the steel was located, it was found that in sections in each of which the longitudinal steel consists of eight ¾-in. deformed round bars, no change in the diameter of the rods had occurred as far as could be determined. In a section reinforced with four 1-in. rods, slight reductions in diameter were found. In a section with four ¾-in. rods, the diameter was reduced to ⅝ in., and there was evidence of a nearly complete failure in the steel. In two sections with eight ½-in. rods, the diameter was reduced to approximately ⅜ in., while in a section with four ½-in. rods, there was a complete break with a reduction in the diameter to about ¼ in. In sections with 25 and 50 lbs. of mesh per 100 sq. ft. area, complete breaks were found at the cracks.

Movement of Concrete Due to Moisture

In commenting on portland cements as produced at the present time and the research work needed on their behavior, the belief is expressed in a letter to Concrete by Alfred H. White, Professor of Chemical Engineering, University of Michigan, that expansion and contraction due to moisture are the influences which are most destructive to concrete. This property is believed common to all normal cements and independent of the composition within wide limits, based upon tests made in the laboratory.

Sample expansion bars from 11 different sorts of commercial cement which passed specifications were made and tested. Most of them were of neat cement but some were of 1:3 mortar. These tests included a number of studies to determine the effect of aging, some to determine the effect of additions of finely ground slag and hydrated lime, and some to determine the influence of very fine grinding. All of these cements expanded when wet and contracted when dry, and while the effects varied somewhat this was not sufficient to make any difference in the general result. Expansion bars were also sawed from various stuccos and pavements and it was found that they showed the same general property and without any material decrease due to age. In addition to these commercial cements, records were kept of 31 expansion bars made from 6 different types of synthetic cements burned in the University laboratory kiln. These included cements of normal composition as well as cements which passed standard specifications but were extreme in composition. One cement was practically free from magnesia; another was practically free from iron and aluminum so that it was essentially a calcium silicate; another was high in iron oxide. All of these cements expanded and contracted with moisture changes as the commercial cements did.

Professor White points out that the fact that portland cement structures expand when they are wet and shrink when they are dry is confirmed by other evidence in published literature and that the only way to prevent this change of volume is to keep the moisture relatively constant. This happens in foundations and bridge piers and also in concrete buildings. Pavements, stuccos, and other concrete exposed to the weather suffer.

The research work which is most needed is that on the properties of normal cement when made into mortar and concrete and subjected to different conditions of moisture. Portland cement was first used almost entirely under water and tests are still made on damp samples. Apparently there are no adequate records of long time tests on concrete kept in the air. The work of Van Ornum in St. Louis shows the effect on compressive strength of immersion into water for a short period after the block has been dried.

Research on the variation of the common composition of cements should be undertaken but it is distinctly secondary, in the opinion of Professor White, to that on the properties of normal cement when used under conditions which are substantially normal.

What are you doing to control the quality of your concrete under practical job conditions?

House Shows

Concrete house and concrete products committees are being organized in Chicago, New York City, Philadelphia and Buffalo in connection with the annual "Own your Home" expositions that will be held this spring under the auspices of the local real estate boards and operating licenses issued by the National Association of Real Estate Boards.

W. D. M. Allan, of the Portland Cement Association, is chairman of the Chicago Exposition Committee; B. H. Wait, district engineer, Portland Cement Association, is chairman of the New York Exposition Committee; L. N. Whitcraft, Portland Cement Association, is chairman of the Philadelphia Exposition Committee, and Walter H. Jones, president of the Federal Concrete Co., is chairman of the Buffalo committee, assisted by P. C. Gallup, assistant district engineer of the Portland Cement Association, Syracuse. All the committees include as members men prominent in the industry and these committees have pledged themselves to see that the concrete products industry is adequately represented at these expositions.

The members of these committees in each city, include:

Chicago—Leslie H. Allen, Hawthorne Roofing Tile Co.; Jacob Bosch, general manager, Calumet Concrete Construction Co.; R. H. Campbell, Atlas Portland Cement Co.; Wallace R. Harris, president Concrete Products Association; L. S. Trainor, district engineer, Portland Cement Association.

New York—G. Edgar Allen, Crozier-Straub, Inc.; C. R. Hulsart, Atlas Portland Cement Co.; G. W. Kaltenbach, American Ambi Corporation; E. B. Kelley; C. E. Lindsley, C. E. Lindsley Co.; Albert Moyer, Vulcanite Portland Cement Co.; L. V. Thayer, Peerless Cement Brick Machine Co.; P. H. Trout; and J. B. Vandever, Nazareth Cement Co.

Philadelphia—Walter S. Giddings, manager, Philadelphia Partition & Building Block Co.; J. Burton Shallcross; George H. Heck, treasurer, Penna Brick and Tile Co.; J. B. Murray of Frank Brennan; W. A. McIntyre, district sales manager, Atlas Portland Cement Co.; Raymond Weeks, president, Penn Building Block Co.; J. J. Staley, president, Staley and Morris; W. E. Thornton, president, Roslyn Concrete Products Co.; W. H. Ellis, Ellis Concrete Products Co. and C. E. Keummerle, Artcrete Products Co.

Buffalo—George S. Hallenbeck, Pittsburgh Testing Laboratories; and George Burnett, Burnett Wilson-Pfohl.

The Chicago Exposition will be held in the Coliseum, from March 21 to 28; the New York Exposition in the 69th Regiment Armory April 18 to 25; the Philadelphia, in the Commercial Museum, May 9 to 16, and Buffalo, in the Broadway Auditorium, May 30 to June 6.

Trade Publications

24-Hour Concrete with Atlas Lumnite Cement is the title of a 32-page paper covered booklet issued by the Atlas Lumnite Cement Co., 25 Broadway, New York City. The book describes the various uses to which Lumnite cement can be put to advantage. This new product is now being manufactured at the Northampton, Pa., plant in ample quantities to meet any demand. Lumnite is a high alumina cement similar to that which has been used for more than 10 years in Europe, principally in France. The Atlas Lumnite Cement Co. was formed after an investigation of alumina cement in France with a view to meeting the demand among engineers and the construction industry, generally, for cementing materials of special qualities.

It is pointed out by the manufacturers that Lumnite develops in 24 hours, greater strength than that developed by other building cements in 28 days. Among the many uses to which it is claimed Lumnite can be put to advantage are: in pavement construction; in street railway track repairs, in underpinning and foundation work; concrete pipe; concrete piles; in subways, in mines, in tunnel construction and in industrial plants and power plants.

Under the heading *Boss Hoists* the American Cement Machine Co. Inc., Keokuk, Ia., has issued bulletin No. 117, describing Boss single drum hoist with independent reversing sheave, double drum hoist, Boss handy hoist and Boss Fordson winch. The bulletin is 8½ in. x 11 in., 4 pages and contains specifications for each type of hoist.

Graver Corp., East Chicago, Indiana, has issued a 20-page bulletin, No. 500, entitled *The Water Supply for Swimming Pools.* The bulletin is very complete in that it describes more than just the refiltering, recirculating and sterilizing equipment furnished by Graver Corp. It has very complete detail in the design and construction of the pools themselves, the accessories to a pool, and is well illustrated with views of pools throughout the country.

Graver Corp. will be glad to supply all interested with a copy of this bulletin.

Heil Bodies and Hoists is the title of a new catalog, No. 140, recently issued by the Heil Co., Milwaukee, Wis. The catalog contains 28 pages and describes and illustrates Heil bodies and hoists, steel dump bodies for hauling sand, gravel, coal, ashes, rubbish, asphalt, or any bulk material; compartment truck tanks of all capacities; Heil hydro-hoists, mechanical hoists, hi-lifts and hand hoists for motor trucks.

Perfection and Permanence is the title of a catalog issued by Doswell & Kover, Fort Wayne, Ind., describing and illustrating the Doswell & Kover air sealed reinforced concrete burial vault. The material and construction of these vaults insures against earth weight and the elements of nature, particularly mineral action, and it is claimed that they are impervious to water and become stronger and harder with age.

The 21st Annual Convention of the American Concrete Institute will be held in Chicago, February 24-27. This is the best single opportunity of the year to learn what others are learning about better concrete.